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ACTINOTHERAPY——PHYSIOLOGICAL EFFECTS†

THE EFFECTS OF LIGHT ON GROWTH AND DEVELOPMENT

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FOR the purpose of studying the effect of sunlight on growth and development, a set of experiments was begun the summer of 1924 at the University of Maine, Orono, Maine. With the co-operation of Dr. C. C. Little, at that time its president, experiments similar to those of Steenbock, Hughes, and Chick were conducted.

For these experiments a clutch of 250 chicks, about one week old, was placed in a greenhouse from which the plants had been removed. They were divided into six groups, each group being placed in a chicken wire cage on the greenhouse benches, all being housed in the greenhouse at night, but the chickens of the first group were allowed to run out of doors during the day. The chickens, composing the other five groups, were kept in the greenhouse constantly, so that they received only the sunlight that had passed through the glass roof of the greenhouse. The greenhouse was as light as any empty greenhouse can be in the summer when the plants are out.

Chickens of the second and third groups received fifteen minutes exposure to the rays of a mercury vapor quartz light each day. All the other chickens were shielded from its rays.

Chickens of the fourth, fifth and sixth groups received only the light that passed through the glass roof of the greenhouse.

All chickens received the regular prescribed poultryman's diet of chick grain, dry mash, sour milk and rock grit. Each group was supplied with water and a sand bath. Chickens in group two received this diet unmodified. Chickens in

†The first of a series of articles comprising a symposium on Actinotherapy to appear each month in The Archives.

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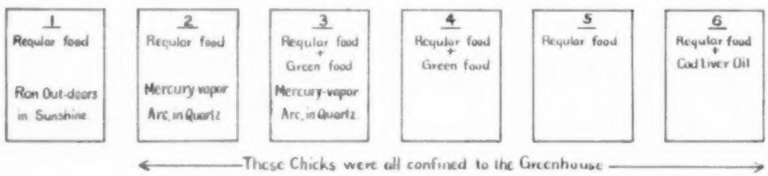
groups one, three, and four were given an added green diet, consisting of chopped alfalfa and grass. Chickens in group six were given the regular diet plus a certain amount of codliver oil, daily.

To portray a little more vividly our division of the chicks and the variables forced upon the separate groups, a schematic explanation is given in Fig. 1.



Daily observations and records were kept of the influence of these different kinds of treatment upon the growth and development.

At the end of the fourth week, the chickens in groups four and five which were exposed to sunlight, which had passed through the glass roof of the greenhouse, did not appear to have as good an appetite, were less vigorous in scratching for their food and in their movement about the pens they were much more sluggish than the other chickens. The appetite and general development of the chickens in group six, which had received the codliver oil, was always below that of groups one, two and three. In part this might be due to the unwillingness of the chicks to take the oil. But it was an outstanding fact that it was only the chickens in groups one, two and three, i. e. those receiving direct sunlight or those exposed to the light of the mercury vapor quartz lamp, that showed the greatest development and were normal in every particular.

In this discussion we are not as interested in the results obtained with the codliver oil or in the effects of the green food, as in the consideration of the three main groups of chickens: groups one, two and five, or the group that was permitted to run out of doors at will during the day, and the two groups that were continuously in the greenhouse—one group receiving fifteen minutes exposure from a quartz mercury lamp every day, and one group which received no radiation other than the sunlight passing through the greenhouse roof.

The differences noted at the end of the fourth week were intensified at the end of the fifth week (Fig. 2). At this time the groups were sharply demarcated. Chickens in group five, the group that had received neither sunlight nor ultra violet radiation, demonstrated in a marked degree the condition known to poultrymen as "weak legs." The legs appeared too weak either for scratching or for support. The chickens remained in a squatting position most of the time, using their wings for additional support while moving about for food. They were unable to stand squarely on their feet and were obliged to assume the characteristic posture peculiar to this disease, with toes

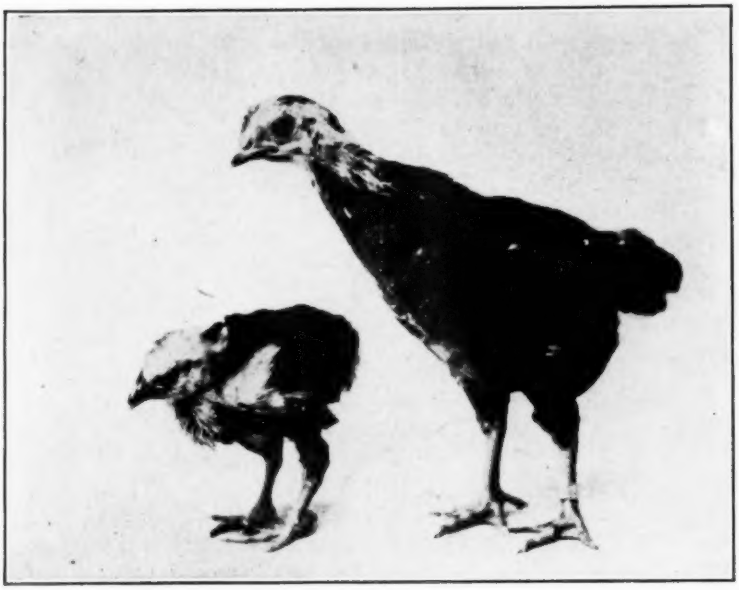


Fig. 2.—The small chicken received only sunlight which passed through the glass. The large chicken received a fifteen minutes daily radiation from the quartz mercury vapor lamp.

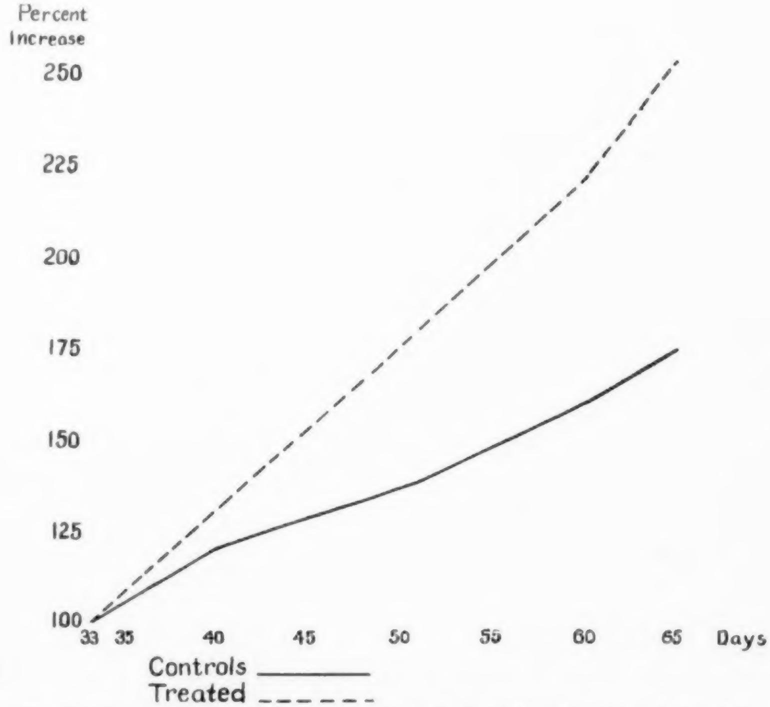


Fig. 3.—A comparison of the rate of growth of chickens in groups 1, 2 and 5.

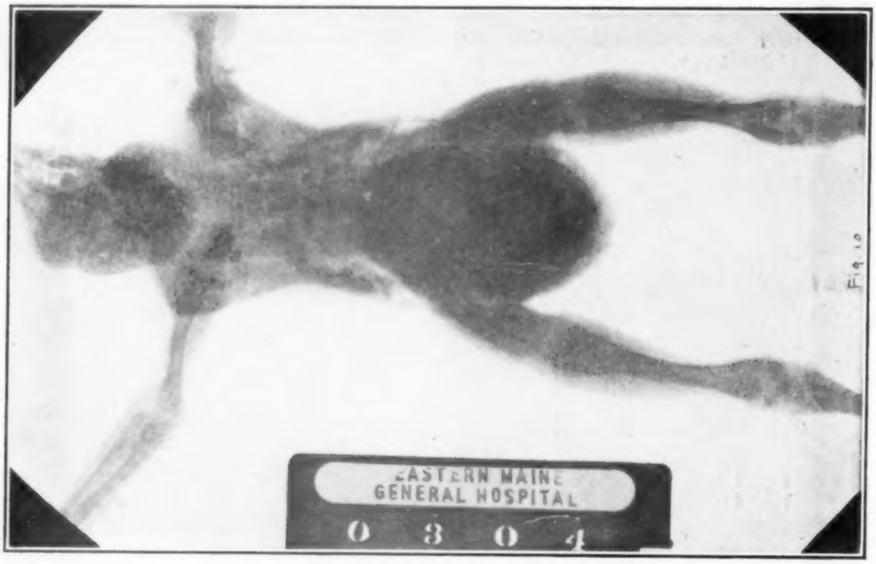


Fig. 4.—A roentgenograph of the smaller chicken in Fig. 2.

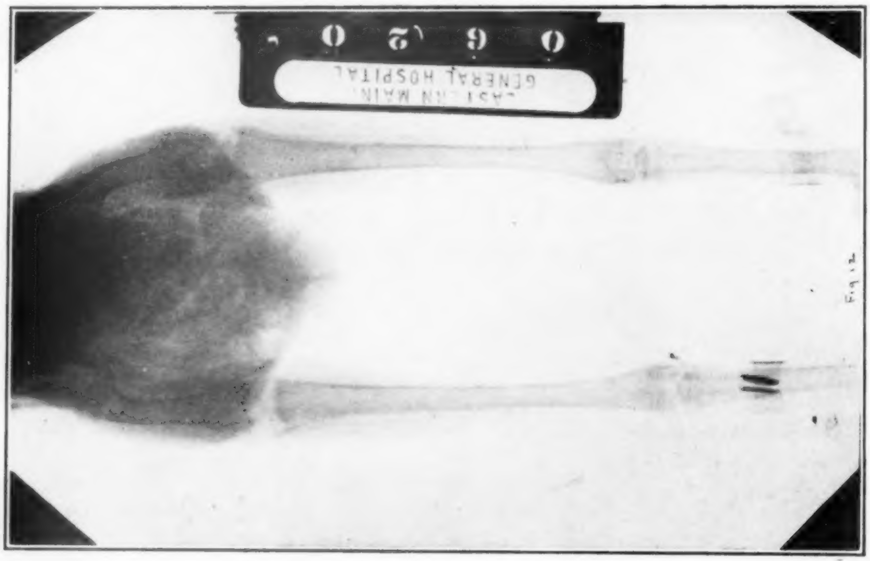


Fig. 5.—A roentgenograph of the larger chicken in Fig. 2.

crossed and head held low in order to maintain equilibrium. Gradually, as this condition became developed, the nails became long and curled, the bills soft, and the plumage ruffled. This disease is comparable histologically and physiologically with the disease in man known as rickets.

The figure alluded to above does not adequately portray the condition that is present. The larger chicken that had been kept indoors but had received the fifteen minutes exposure to ultra violet light daily may also represent the group that ran out of doors. Only a slight difference could be noted—the group that had received the artificial ultra violet light was a little farther advanced and a little heavier, generally, than the one receiving the sunlight. The smaller chick, on the other hand, is not a typical representative of the group that did not receive the ultra violet light, but it was the only chicken in the group that was able to stand up to have its picture taken. This condition has been demonstrated by others and is clearly depicted in an illustration accompanying an article by Steenbock published in 1923.

The difference in the rate of growth that led to such an end result is interesting. In Fig. 3 the percentage increase is depicted from the thirty-third to the sixty-fourth day. The dotted line in this figure shows the total increase in weight of all the chickens in groups one and two. The continuous line indicates the total increase in weight of all the chicks kept as controls, in group five. In this chart the number of days' growth is measured along the horizontal axis and the percentage increase in weight is measured vertically. The figure represents only the last thirty days of the experiment.

The graph demonstrates one striking fact. At the end of the sixty-fifth day of treatment the total weight of the chickens receiving only sunlight passing through the greenhouse roof is about one-half of the total weight of the chickens exposed to outdoor sunlight or the light from the ultra violet lamps.

To depict more clearly the lack of development of the long bones in the small chick shown in Fig. 2, an x ray photograph, Fig. 4, is presented. You will note there was such a small amount of calcium deposited that portrayal was difficult. At the joints, cartilage remains so that the bone capsule of the leg has not united with the shaft of the bone. These bones are very immature. Compare with this the straight, strong, well-calcified bones, Fig. 5, in the roentgenograph of the larger chicken of Fig. 2. The condition shown in Fig. 4 is typical of the condition that existed in the group that received no ultra violet radiations from the lamp, or from direct sunlight. The condition shown in Fig. 5 is typical of the chickens in group two that received artificial ultra violet radiation. The bones of the chickens in group one, that received the sunlight, were not quite as far advanced as those of group two which were exposed to the quartz lamps.

The retardation in the development of the bones in the chickens of these groups

was paralleled in the development of the secondary sex characters (comb, etc.) since these characters had not begun to develop in the chickens of the unradiated group at a time when they showed an advanced stage of development in the chickens of the irradiated group.

It is apparent that the chickens which were exposed only to the sunlight that passed through the glass roof of the greenhouse lacked something in the environmental conditions which was experienced by those receiving either direct sunlight or the light from the quartz mercury vapor lamp. This lack in the environmental condition must be in the differences in the illumination to which the chickens were exposed, for the differences in diet, excepting in group six, where codliver oil was added to the regular diet, produced no discernible results. The differences in illumination will be made clear from Fig. 6. This figure shows an array of spectral colors arranged according to their wave length, together with the spectral limits of the light received by each group of chickens.

violet light down to wave lengths of about 2900 Angstrom units. Glass, such as that in window glass and the kind used in the greenhouse roof, transmits some of the heat rays, all of the visible light rays—in fact all sunlight down to 0.31 microns or 3100 Angstrom units. But it is this narrow band between 0.29 and 0.31 microns, or between 2900 and 3100 Angstrom units, filtered out by the glass which contains the ultra violet rays in sunlight. The mercury vapor quartz lamp, on the other hand, gives off both visible light and ultra violet light down to wave lengths of less than 0.2 microns or 2000 Angstrom units.

Since glass filters out all rays with wave lengths less han 0.31 microns the small band of ultra violet light lying in the narrow limits between 0.31 and 0.29 microns cannot pass through. Chickens in groups four, five and six, kept in the greenhouse, received only the rays down to 0.31 microns and were thus deprived of the ultra violet rays of sunlight. The chickens in group one, that ran out of doors, received, in addition to the light

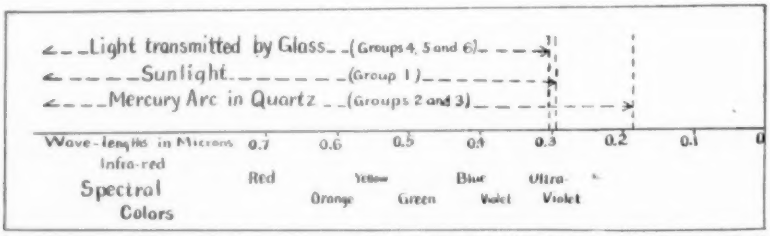


Fig. 6.—Spectral colors arranged according to wave length, showing the spectral limits of the light received by groups of chickens.

A study of the sun's spectrum will show the relationship between visible light and ultra violet rays. Sunlight contains, besides heat and visible light, ultra

received by the other chickens, this narrow band of ultra violet rays. The chickens in groups two and three received the visible light and all the ultra violet rays

transmitted from the mercury vapor quartz lamp, i. e. they were exposed to ultra violet rays having wave lengths down to approximately 0.2 microns. It is probably this extra region which accounts for the small differences that were noted between the chickens receiving sunlight and those receiving radiation from the mercury vapor quartz lamp.

Since chickens grow and develop normally in full sunlight and since these experiments show that they do not grow and develop normally in light transmitted by glass, it is obvious that the differences in the various groups must be ascribed mainly to this narrow spectral band. This band is so narrow that, by analogy with the visible spectrum, it may be considered a pure spectral color lying in the ultra violet at the extreme limit of sunlight.

It is not difficult to understand the variation in these chicks nor to understand why the antirachitic properties of sunlight are limited to this narrow band of the sun's spectrum. The first law of photochemistry propounded by Grotthus states that only the light which is absorbed can bring about photochemical change. The second law of photochemistry is Lambert's law which states that the fraction of light absorbed by a homogeneous absorbing medium is independent of the intensity of the incident beam. Lambert's law may be stated mathematically as follows:

$$i = I\epsilon^{-\mu d}$$

in which i is the intensity of light in an absorbing medium after it has passed through a thickness of absorbing medium, d, when the original intensity is I and the absorption is μ. ϵ is the base of the natural system of logarithms. μ is the so-called absorption index of the medium under consideration. The value of μ is a function of the wave length of the light, and the absorption becomes greater as the numerical value of μ increases. Using this equation, if the intensity of the light, i in per cent, were plotted vertically against the thickness of the absorbing medium, d in microns plotted horizontally, the curve would become steeper the greater the value of μ (Fig. 7). When the value of μ is very high, the curve becomes very steep, which means that the intensity of light i, is reduced to a very low value by passing through a comparatively thin layer of absorbing medium.

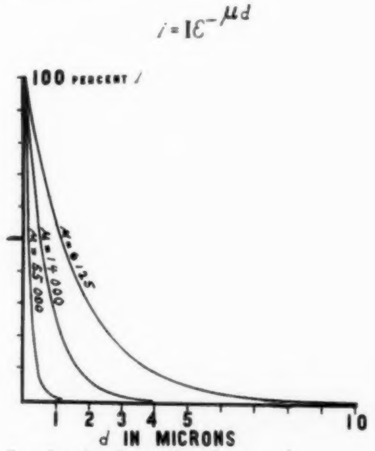


Fig. 7.—Lambert's absorption law.

The absorption spectrum of a substance depends upon the relation between the value of the absorption index of the substance and the wave length of the

light absorbed. The absorption spectrum for egg white, is represented graphically in Fig. 8, in which the wave lengths of light are indicated horizontally and the absorption index vertically. The absorption spectrum of protoplasm is not very much different from the absorption spectrum of egg white. It will be noticed that the absorption index of egg white begins to rise rapidly very nearly at the place where the sunlight ends.

There are two regions in the sun's spectrum where protoplasm absorbs, the heat region, and the ultra violet, Fig. 9. (The wave lengths of light in microns are arranged along the base line. In order to give the figure more convenient dimensions a logarithmic scale is used for the wave lengths.) That part of the sun's spectrum having wave lengths greater than 0.8 microns is called the infra red or heat region of the spectrum. That protoplasm absorbs energy in this region is evidenced by the fact that we are warmed by the sun's rays. Visible light is only slightly ab-

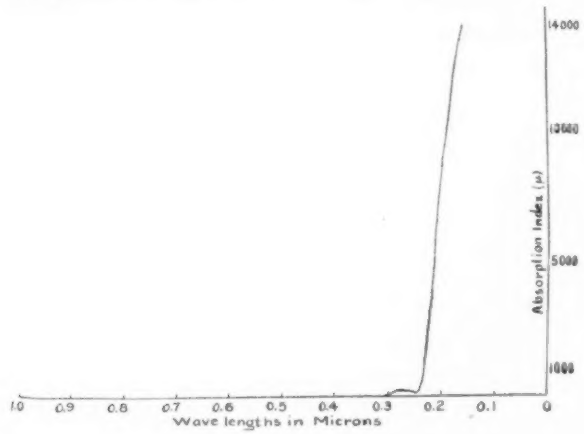


Fig. 8

Fig. 8.—Absorption spectrum of egg white, probably similar to protoplasm.

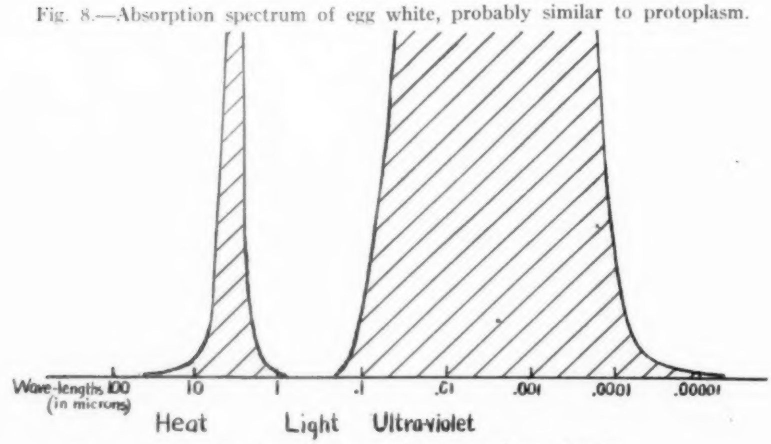


Fig. 9.—Regions in the spectrum where protoplasm absorbs.

sorbed by unpigmented protoplasm. Protoplasm also absorbs the rays in the ultra violet region of the sun's spectrum. This is the basis for the experiments that I have just related. We can readily understand that sunlight which had passed through a water screen which does not transmit the heat rays of the sun would not warm us. In precisely the same manner, the ultra violet rays of the sun's spectrum are filtered out by glass screens and are unavailable, after passing

Energy from both parts of the spectrum through the glass, for protoplasmic absorption.
where protoplasm absorbs strongly is necessary for the normal growth and development of the chickens; and it has been found by experiment that these rays are necessary for the normal growth and development of many other organisms, including man.

It is a fact long observed that light influences the shape and growth of plants. Any one who has raised plants in a window box knows that the plants must be turned to expose all sides successively to the light, if a symmetrically formed plant is to result. This is because the growing tips bend toward the light and the leaves take up positions that expose the greatest amount of leaf surface to the light. Plant physiologists call this bending toward the source of illumination "positive phototropism." A conifer, for instance, is cone-shaped, and the shape is determined by the light that falls upon the tree. The mechanism by which light does this is very interesting.

If the tip of a conifer is cut off, one of the side branches will turn up and form the new tip so that the tree will maintain its conical shape. This turning up is the joint action between light and the effect of gravity. Perhaps you have noticed that in a group of conifers, the entire group forms a cone.

Probably everyone has seen conifers that have not followed this rule, for instead of growing vertically they have projected hemselves horiztonally. These conifers have a hereditary disease which follows the mendelian law. The mechanism that should have made the tree a cone does not function normally, so that the light that should have kept it vertical now turns it over and makes it horizontal.

The sensitiveness of plants to light is far greater than is commonly supposed. Blaauw performed numerous experiments with an oat seedling to determine the relation between the length of the exposure, illuminating from the side, and the intensity of the light required to bend the seedling toward the light. An intensity of 26,520 candle meters required an exposure of but 0.001 second, while an intensity of 0.00017 candle meters required an exposure of 43 hours to bend the seedling toward the light. Blaauw established the fact that not only did the amount of exposure needed decrease as the intensity increased, but that these were related in accordance with the well-

known law, the so-called "I x T" law of Bunsen and Roscoe, often referred to as Draper's law. This law was formulated to express the action of light on a photographic plate and states that for a constant amount of blackening (after a standard development) the product of the intensity and the length of exposure is a constant.

Consider the law as it applies to the photographic plate. From the experiments that have been carried on it is established that the light has produced a certain amount of chemical change in the plate; that is, the number of silver grains that are made developable, is proportional to the product of the intensity of the light and the duration of the exposure.

Blaauw found that this law held true for the oat seedling over the enormous range of intensities he used,. It appears, therefore, that light produces in the oat seedling a photochemical substance, which is capable of controlling the shape of the plant. To do so it must control certain physiological functions in the plant and substances in animal tissues which thus control physiological processes, we call vitamins.

Blaauw's results furnish strong evidence that the phototropic response only occurs when the amount of this product reaches a certain minimal value.

The question as to how this photochemical substance, produced by the action of light, can cause the plant to bend has brought forth much experimentation. The oat seedling when illuminated from the side bends at a region about five millimeters below the tip, but this region is not sensitive to light. If one shades various parts of a young oat seedling by small cylinders of tinfoil, supported in a manner so as not to touch the plant, one can demonstrate that it is only the very tip of the seedling that is sensitive. But if a photochemical product is produced in the photosensitive portion at the tip it must be transferred to the nonsensitive region that bends.

Darwin investigated this problem by conducting some very ingenious experiments. He cut spirals in the tip of the seedling so this substance would have to wind as it came down. He cut notches and made it go back and forth across these notches, but the oat seedling was never confused. In some curious way the substance always got to the nonsensitive portion and the plant bent as it should.

It has further been shown that the propagation of the stimulus can continue even across a cut surface which separates the region of stimulation from the region of bending. Removing the tip of the seedling by transverse section and illuminating only this tip while it was severed from the rest of the plant, then sticking it on in the original position with an intervening layer of gelatine a tenth of a millimeter thick, the non-illuminated portion of the seedling below the point of section will bend toward the source of light. Substituting for the gelatine layer an equal layer of cocoa butter the plant

will not bend. Therefore, a continuity of uninjured cells is not necessary for the conduction of the phototropic substance; such conduction can take place even through the gelatine across a section of destroyed cells, but cannot take place through a substance not water soluble. The fact remains that this photochemical substance which is water-soluble is produced by a balanced intensity of light and length of exposure on the tip of the plant and is transmitted to the nonsensitive portion (not requiring a conductivity of uninjured cells) there inevitably to cause bending towards the source of light.

The minimal amount of light required to cause the oat seedling to bend is far below the threshhold of human vision. To appreciate the infinitesimal amount of light required, consider modern thermopiles. Physicists have developed thermopiles sufficiently sensitive to measure the intensity of the heat from the North Star, requiring 45 seconds for the heat to cause the galvanometer to deflect enough to give a reading. This they consider an achievement. But the eye can perceive the North Star in a wink. The eye responds to a much smaller amount of energy than the physicist can measure. The oat seedling is 1,000 times more sensitive to light than the human eye, so one can appreciate that it requires an exceedingly feeble light to produce this photochemical substance in the plant sufficient to cause bending. This extreme sensitiveness of plants to light justifies the belief that only a very small amount of photochemical substance is required to initiate the physiological processes which result in the phototropic response.

Whether it is the photochemical product itself which diffuses from the stimulated to the bending portion of the plant or whether the photoproduct initiates a chain of chemical changes so that there is a sort of physiological amplification of the stimulus, no one can say. In any case, a sequence of physiological events occurs through which a modification of plant structure is brought about.

Let us for a moment consider the probable changes which result in the bending of the plant. To do this a superficial discussion of the mechanism of growth is necessary. Suffice it to say, two things are involved. One is an increase in the total amount of substance and the other is a modification called differentiation, of the substance into structural elements.

Considering first the modification of substance: in the tip of the plant, there is a single cell called an apical cell, which is triangular in longitudinal section or pyramidal in shape. It remains young or embryonic, and by its continued division it produces rows of cells which will constitute the tissues of the plant. The cells nearer the top are younger and those at the bottom are older. The tip of the plant is the region where the photochemical substance is formed. The lower region is where the plant bends.

If cells are examined at various levels from the photosensitive region to the

bending region , it will be found that the cells near the top are primarily protoplasm, the nucleus is large, and the walls of the cell are formed of pectin, a sugar, elastic physically. As sections are made lower in the stems nearer the bending portion, older cells are seen. In these cells, certain changes in the osmotic relations cause vacuoles to form, which increase in size until they occupy all of the central portion of the cell and the protoplasm becomes a very thin layer just lining the wall of the cell. As water is absorbed, the cell is stretched and increases in length. It is this increase in length that is the growth of the plant.

The second alteration which contributes to the bending of the plant is differentiation. Differentiation is a modification of substance into structural elements. When the cell differentiates, the protoplasm lays down on the inside between the protoplasm and pectin layer, or middle lamella, layers of cellulose or wood. These layers are deposited in different patterns, sometimes in spirals, concentric rings, patches, or lacework structures. It is this variation in the cellulose layers, laid down on the inside by the activity of the protoplasm, that constitutes the differentiation. The cellulose is not elastic, so that when differentiation occurs, growth ceases.

Considering again Grotthus' law, that only the light which is absorbed can bring about photochemical change and correlating this with Lambert's law that the fraction of light absorbed by a homogeneous absorbing medium is independent of the intensity of the incident beam, it is obvious that the photoproduct will be formed in greater amount on the side of the plant that is exposed to the light. Hence as transportation of materials in plants occurs most readily in the direction of the axial growth, the tissues on the side that is exposed to light have greater amount of photochemical substance, become differentiated and cease to grow, while those cells on the other side are stillcontinuing to increase in size. Bending towards the beam of light must result.

Light has a very pronounced influence upon the rate of growth of the plant. Generally, an increase in illumination retards the rate of growth, because of the increased differentiation. Most plants put on the most rapid growth at night, particularly at eight o'clock in the evening and two o'clock in the morning.

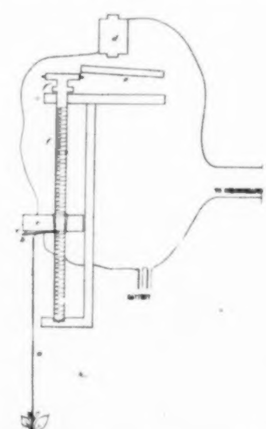


Fig. 10.—Diagram of device to record growth of plants under varying light conditions.

A number of years ago the author devised a piece of apparatus (Fig 10) for measuring and recording the rate of growth of plants. The sensitiveness of

the apparatus was such that it would record an increase in length of 1 / 1000 of an inch. With a rapidly growing four o'clock seedling the plant will record this increment of growth every fifteen seconds.

The accompanying figure (Fig. 11) is a record of the growth of this plant in the laboratory in Cambridge, Massachusetts, during the month of February. Time is measured horizontally and the rate of growth is measured vertically. The laboratory became dark about five in the afternoon and the rate of growth began to increase markedly at this time, continuing until seven o'clock when it was at its height. There was a smaller rise in the growth curve at about two o'clock, probably due to the fact that the laboratory was cooler at this time. The curve drops rapidly between three and four o'clock in the morning only to begin to rise again at precisely four o'clock. The sharp bend in the curve at this hour is to be correlated with the fact that the day fireman came on duty at this hour and started the fires in the laboratory heating plant. Curves made on successive days all showed a sharp bend at exactly this time, a rather indirect but effective method of checking on the punctuality of the fireman. The curve again falls at daybreak.

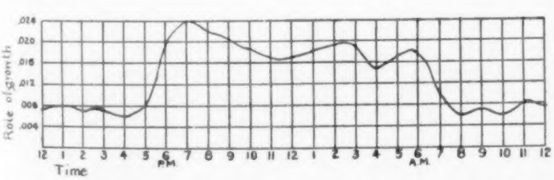


Fig. 11.—Chart showing variation in rate of growth of seedling for one day.

Light influences the rate of growth, but does not control it, for the plant continues to grow during the day, and a study of a great many growth curves reveals the fact that growth is a rhythmical process.

Now to recognize the reason for the bending of the plant. Protoplasm absorbs light from the two extremes of the spectrum. As the result of this protoplasmic absorption, a photochemical reaction takes place which causes the cells to differentiate as manifested in the laying down of a cellulose layer. Only the protoplasm in the cells on the side from which the light shines is capable of causing this differentiation, while the cells on the other side of the plant continue in performing their other functions: the absorption of water, stretching and growth. Since the plant has no conducting system, the photochemical substance formed on the radiated side diffuses down the long rows of cells causing differentiation and stopping elongation. Growth on the opposite side mechanically causes a bending towards the light.

Referring to the question of the conifer and its conical shape: branches of the conifer grow outward in the search for light, we might say. The cells continue their stretching and growth, increasing in length until they receive light enough to cause differentiation. When differentiation occurs, growth stops. In this way every branch grows to a given distance, when the influence of light causes its differentiation and stops its growth. With the younger branches above and the older

branches below, naturally the conifer will assume a conical shape.

Examining a plant from the point of view of the sun, one would see that all the leaves fit together to form a mosaic. The leaves do not shade one another. Since the plant must make starch by photosynthesis, it must have its leaves exposed. The petiole of each leaf grows until the leaf is out into the sunlight at which time differentiation occurs and the elongation of the petiole ceases.

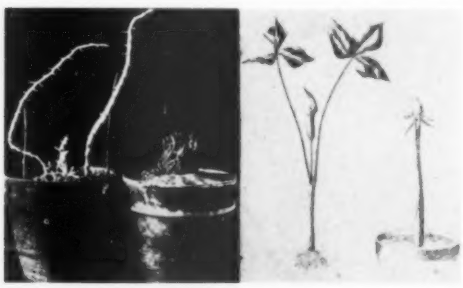


Fig. 12.—Photograph of potato sprouts grown in dark in a portabe dark chamber.
Fig. 13.—Photograph of normal Indian turnip and one in a portable dark chamber.

It is a well-known fact that with the exception of some of the fungi and bacteria, plants cannot grow and develop properly in the darkness; the stems are more succulent, there is a deficiency in the amount of mechanical tissue, and the green color of chlorophyl-bearing plants does not appear. A potato sprout growing in a dark cellar is full of water, it is succulent, it grows tall (Fig. 12). It is said to be "etiolated," a yellow pigment etiolin being formed instead or chlorophyl. In other words differentiation has been stopped with the elimination of light and there is nothing in the physiological processes as important to the welfare of plants as the process of light bringing about this differentiation. Sachs, a botanist, after studying plants which grew in the dark, came to the conclusion that the plant lacked for its construction a specific "formative material," a photochemical or growth determining substance which is formed in the leaves of the plant by the action of sunlight. He went further to say that ultra violet rays were necessary for the formation of this substance.

MacDougal, in his memoir on the influence of light upon growth, pointed out that a plant grown in darkness does not show the same degree of differentiation morphologically that is found in corresponding plants of the same age that had been exposed to illumination. The tissues of the stems, leaves, and floral organs show only limited departures from the embryonic condition when grown in darkness. Comparatively few plants are able to produce a normal abundance of fruit when shielded from the sunlight by glass. MacDougal further demonstrated with a perennial plant that by exposure to light for one year, followed by seclusion to darkness for a year, the effect of light would last from one year to another. In other words the physiological effects of exposure to light may become manifest at a time long after the exposure.

The conclusion of MacDougal's monograph, were it couched in zoological rather than botanical terms, would be a fairly good description of rickets with all its pathological manifestations.

A comparison of the behavior of the normal and etiolated plant offers a demonstration of the fact that growth and differentiation are not only independent but easily separable processes. While a deficiency in the amount of light results in a delayed or complete failure of tissue differentiation, an exposure to an excess of light may result in a premature differentiation as shown by the experiments of Gager.

In these experiments, it was demonstrated that rays other than those of the sun will cause this differentiation. Gager exposed kernels of corn to the rays from radium. The seeds germinated and grew when the corn was planted, but when the plants attained a height of a few inches above the ground the growth ceased. An examination of the tissues showed they had been prematurely differentiated into somatic tissues and the plants had died of senility before sexual maturity had been attained. Radiologists have come to realize that exposure to the x rays causes the skin to become senile. Those who have worked with radium and who have exposed their fingers to its rays, have a senile condition of their fingers, due to the fact that there has been an over-differentiation of the tissues.

The differentiation of tissues in plants which has been discussed has to do not only with the deposition of cellulose, but it also influences if not controls, the entire chemistry of the plant. Bleached celery is devoid of cellulose but is abundant in sugar. The sugar cannot be polymerized into cellulose. Often in rickets an analogous condition is found, there is an abundance of lime salts in the blood, but the process of differentiation cannot occur.

If one interferes with the rate of tissue differentiation in a growing organism, the whole process of development may be thrown out of order and the organism may develop into a monster. Hertwig exposed frog's eggs to radium rays and found that the embryos developed abnormally, forming "radium monsters," due apparently to disturbances in the normal sequence of differentiation. Both Gager and Hertwig found irregularities in the nuclear changes which accompany cell division.

The stimulating action of light in producing morphological differentiations is not due to any direct action which the rays exert on a particular tissue, or upon any part of the organ concerned. The stimulative effect of the illumination may be received by one portion of the body and transmitted to another, or impulses may be communicated to organs not actually formed at the time the stimulating rays were received. Radiating one branch of a twig of horse chestnut will cause differentiation to occur over the entire plant.

We do not wish to be understood as saying that the exposure to light is the cause of tissue differentiation. As in many other physiological processes, it is determined by a great number of conditions. The exposure to light is one of the determining conditions and when

the light intensity is reduced below the optimum it may become the limiting factor.

Plants are constantly subjected to stresses and strains by the force of gravity, winds, etc., and are obliged to meet them by the construction of mechanical tissues. These tissues—the veins in the leaves and the fibro-vascular bundles in the stems—are not only arranged to resist best the stresses and strains, but are given remarkable mechanical resistance by their microscopical structure. A study of these structures demonstrates a pattern that resembles the beams in a steel structure, with a web and a couple of hard plates on either side—a girdle-like arrangement. When a plant grows in the absence of light, these mechanical tissues fail to develop; and while it is true that the differentiation and development of the entire organism is abnormal, a failure in the development of the mechanical tissues is more conspicuous and hence attracts attention. Bleached celery is tender because of the lack of mechanical tissues.

The mechanical tissues in animals are likewise constructed to bear the stresses and strains put upon them. It was a study of the arrangement of the structures in animal tissues that gave Galileo, father of engineering, his principles of structural engineering. A weight hanging from a cantilever, bends down and produces a compression in the lower part of the beam and a stretching in the upper part, forming compression and tension lines of force. Every mechanical structure has these two kinds of strains—compression and tension strains. These principles applied to the engineer's crane head resemble markedly the stress and strain lines seen in the head of the femur (Fig. 14). A radiograph (Fig. 15), demonstrates the arrangement of the trabeculae in the head of the femur.

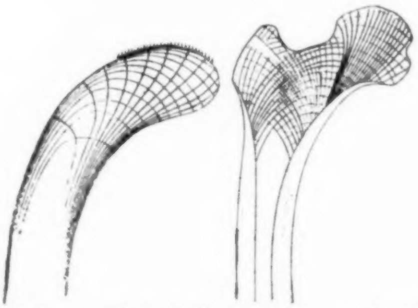


Fig. 14.—Stress and strain lines in the crane head and in the head of a femur. (From Thompson's "Growth and Form.")

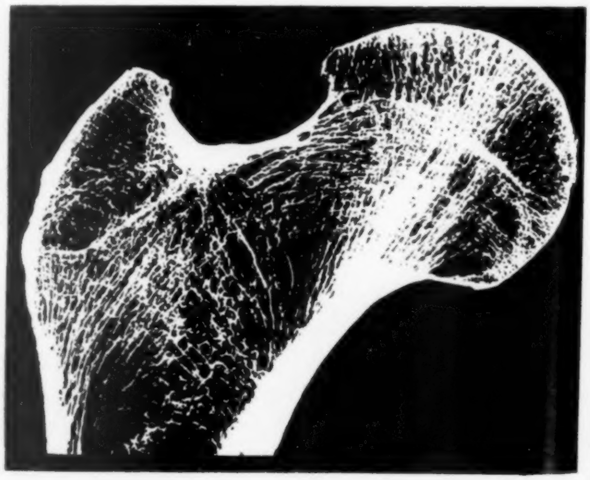


Fig. 15.—Roentgenograph showing arrangement of trabeculae in head of femur. (From Thompson's "Growth and Form.")

The femur consists of a hollow shaft of bone expanded at the ends into articulating heads. It is filled with marrow and contains at the ends a meshwork of

bone plates called trabeculae. It will be seen from the figure that these trabaculae are laid down along the stress and strain lines. Koch at Johns Hopkins University carried on investigations in which he showed very carefully the stress and strain lines in a femur, and worked out the relative load that the different parts of the bone would have to support when carrying its load. For example, he points out that an average man, of about 150 pounds, when he runs puts a weight of a little over a ton to the square inch on the head of the femur. According to Koch, not only are these trabeculae laid down precisely along the stress and strain lines, but the thickness of the trabeculae are proportional to the loads placed upon them. All the bones of our bodies are characterized by this remarkable architecture, an architecture in exact agreement with the practice that was developed by our best engineers.

A change in posture, an alteration in the weight bearing, a change that results when broken bones are set out of line or from the transplantation of bone in bone grafting, all produce an alteration in the stress and strain lines. It will be found that the trabeculae have taken on a new configuration which conforms with the new stress and strain line pattern. There has been a solution of the trabeculae and a redeposition in such a manner as to carry the new load. It is as if an engineer could build a bridge in such a manner that the timbers in the bridge would melt themselves down and rearrange themselves to take care of the shifting traffic.

The deposition of bony material in the developing child is one of the processes of tissue differentiation referred to above. Sunlight is as necessary for the child as for the plant to activate the protoplasm to the production of this structural or supporting material. In the absence of ultra violet rays this differentiation does not take place properly, because there is a failure in the deposition of the calcium and phosphorus salts in such an organized manner as to meet the mechanical demands. When a child learns to walk and puts weight upon the bone, the trabeculae meshwork that would normally be formed to meet the stresses and strains is not built. Compensation can only imperfectly be accomplished by the curving of the bone, the production of bowlegs, large joints, square heads, rachitic rosary, lordosis, kyphosis, etc.

There are other factors besides light which influence the shape of bone. Pfeffer, experimenting with a plant that was growing, measured the tensile strength, then added little weights to the plant. He found that in two days he could increase the tensile strength of the plant 400 per cent without any apparent change in the size of the plant. The plant under the additional load rearranged its timbers, as it were, according to the new lines of stress and strain.

Bowlegs may be due to mechanical deficiencies of the bones rather than to putting the weight of the body on them too early. All the forces that are brought into play in building the mechanical structure of bone are not known, but it

appears (as in the case of the plant) that the weight placed upon it acts as a necessary stimulus to which the organism responds by laying down the strengthening mechanical structures precisely adapted to bear the weight.

The Bradford splint, rather recently developed, has had great success. Here probably the reason for its success is its flexibility.

The experiments that have been done that light, although not the sole factor, is one of the necessary elements for the proper differentiation of tissues. This does not apply to the structural tissues alone, nor to bone only, for the chickens, we must remember, were unable to differentiate their secondary sex character in the absence of light. The entire endocrine system must be involved. It is a well-known fact that people who live in the tropical countries come to sexual maturity earlier than people who live in the temperate zones. Light, it seems, is concerned with the whole physiology of the organism, having to do particularly with the processes of differentiation.

The experimentation of Krogh on the mechanism of capillary flow may also be recalled. When the capillaries fill with blood, the Rouget cells, or muscle fibers at the end arterioles and venules, extend and the blood flows into the capillary. The Rouget cells at the end of the capillary, at both the arterial and venous ends, close, entrapping the blood in the capillary. A peristaltic movement is set up, the Rouget cells contract in a rhythmical manner, pumping the blood from one end of the capillary to the other until the exchange of gases, etc., is completed. The end cells then open and an increased peristaltic wave sweeps the blood out of the capillary. The capillary comes to rest in a contracted condition and does not fill with blood until the Rouget cells have recovered from their excitation.

This mechanism that Krogh discovered was considered at the time he received the Nobel prize two years ago as being as important as the heart in the circulation of the blood, for it is this mechanism that controls the supply of blood at the point of consumption. It is as important in our circulatory system as the spigot at our sink is in our city water system.

Krogh demonstrated the great influence of sunlight on this capillary system. He found that when he exposed one part only of the capillary each cell in the lighted patch became paralyzed, the others remained unchanged. In this manner a very sharp pattern of erythema or sunburn was produced by exposure of these Rouget cells to sunlight. But after the tan had disappeared and the body had bleached, hot or cold water will redevelop the pattern—you can bring back the erythema, so there is something left from your summer vacation at the seaside long after the debts have been paid. This may be due to the fact that there are some chemical differentiations that occur in these cells.

It is known that the ultra violet rays of the sunlight do not penetrate the or-

ganism far enough to reach the bones and cause there the differentiations described. The light is probably absorbed by the surface layers of tissues, and its stimulating action must, therefore, be transferred in some manner to the developing bone. We know that the entire organism is affected by radiation of a part, so there must be some means of transportation.

The same condition is true in plants, for it has been found that illuminating one part of the plant affects the differentiation and development of parts not exposed to the light. Now, in plants there is no specialized nervous tissue which serves to transmit stimuli, and it seems reasonable to believe that some photochemical product is formed in both plants and animals. It is this photochemical product or "formative material," as Sachs calls it, which is necessary to bring about the differentiation.

In plants this material is formed in the tissues exposed to the sunlight, but it appears that in animals the substance stimulating differentiation may either be formed directly in the organism by exposure to ultra violet light or it may be taken in with the food, for we know that addition of codliver oil to the diet has a beneficial action in regulating faulty calcium metabolism. The recent investigations of Hess and Steenbock and others have shown that when certain substances as cotton seed oil, linseed oil, lettuce or dried milk are exposed to the ultra violet light and then added to the diet, the diet is rendered anti-rachitic; or speaking more generally, the diet becomes suitable for stimulating normal differentiation.

It may be instructive to draw an analogy between the morphogenic action of light and the action of light upon the photographic plate. When we expose the photographic plate in a camera a latent image is formed in the sensitive film of the plate. This image is invisible to our eyes. The plate appears exactly the same before and after exposure. The latent image is not to be confused with the image which will appear upon the plate when it is developed. By latent image we mean the peculiar photochemical change which has taken place in the silver grains of the plate and which has transformed them into a developable condition. When the plate is subsequently developed, it is found that only those silver grains which have been brought into the developable condition are affected, providing the developer is not too warm.

In the development of a photographic plate the silver grains are reduced while the developer is oxidized. It is conceivable that as chemists we might have been interested rather in the oxidation of the developer than in the reduction of the silver salts; in which case every photographer would have learned that if he wished to oxodize an alkaline solution of hydroquinone or pyrogallic acid (or any other developer) at room temperature, he could add to the developer silver salts dispersed in gelatin, and it would be an

essential detail that the gelatin and the silver salts must have been previously exposed to the light. A brief exposure would be sufficient and the exposure could have been made several months in advance.

Moreover, our photographer would also learn that the emulsions of the silver salts in gelatin varied in their sensitiveness to light. There would be fast or slow emulsions depending upon the method used in "ripening" them, and his familiarity with the process would undoubtedly in time blind him to the mystery of the mechanism and he might cease to wonder why it was necessary that the emulsions be exposed to light in order to oxidize the developer, just as he has now ceased to wonder about the mechanism through which the light makes the photographic plate developable.

Let us now compare the blood to the photographic emulsion. The blood flowing through the baby's arm may be exposed to ultra violet light of a suitable wave length. Then, after this exposure, when it comes into contact with the embryonic bone tissue, the latent image produced by the light in the blood may be developed by the chemical interactions which occur in connection with the metabolic changes having to do with the differentiation of bone tissues. In a like manner we may consider that the radiated foods of Hess and Steenbock carry a latent image capable of influencing metabolic changes having to do with differentiation of bone tissues.

We do not possess at the present time sufficient information to describe further the nature of these photochemical products or the chemical changes which they induce. We only know that they are necessary for a proper growth and development of the organism.

We may carry our analysis somewhat further, however, by discussing briefly the nature of photochemical change. If every molecule and atom in a chemically reacting mixture were in a suitable condition to take part in a chemical change, every chemical reaction would proceed with the velocity of an explosion. That all chemical reactions are not explosions testifies to the fact that only a certain fraction of the atoms or molecules are in such a condition at any one time that they can take part in the reaction.

When we warm a mixture of chemicals in a beaker in order to increase the rate of reaction more of the chemically passive atoms or molecules are changed into a chemically active condition and the speed of the reaction is a measure of that fraction of the atoms or molecules that have been brought into the activated condition.

If we accept for the time being the electron theory of sub-atomic structure, the atom may be compared to a minute solar system, the electrons taking the place of the planets and revolving about a central nucleus (or sun); and according to the theories of Bohr, Summerfeld and others, when the atom is chemically activated some of the electrons which are revolving in the outer orbits are caused

to revolve in orbits which are farther flung from their central nuclei, so that they revolve in highly eccentric orbits after the manner of comets rather than in the more nearly circular orbits as do the planets.

These outer electrons seem to serve in some way in linking the atoms together to form molecules and it is believed that one of the first steps in a chemical union is the throwing off of these valency electrons into farther flung orbits. This has been identified with the chemical activation of the atoms. The energy required to throw the electrons into far flung orbits may be derived from the heat energy of the reacting mixture, and it is supposed that this energy is acquired by the atoms at a moment of molecular collision.

It is known that when light, particu larly ultra violet light, falls upon some substances they are caused to give off electrons (photoelectric effect). These electrons probably are derived from the atoms of the material upon which the light falls. It is, therefore, easy to understand how an energy like light can hurl electrons into far flung orbits and thus chemically activate the atoms. When atoms are activated by absorbing light energy, we call the resulting chemical change, photochemical reaction. If the atoms are activated by heat energy, as described above, we call the resulting change thermochemical.

There are many kinds of atoms and molecules which can be activated by light energy and there are certain kinds of chemical reactions, such as the photosynthesis which occurs in green plants, which can be brought about only by light energy. These reactions are referred to as specific photochemical reactions. The experiments upon the chickens referred to above seem to indicate that the formation of the latent image through which tissue differentiation is brought about is a specific photochemical reaction.

It is well known that silver salts have their sensitiveness greatly increased when they are dispersed in the gelatin of the photographic plate. Moreover, this sensitiveness is further enhanced by the process of "ripening" the emulsion; and during the ripening process certain physical changes occur in the relation between the silver grains and the surrounding gelatin. We may suppose that this physical alteration consists in establishing certain molecular orientations of the silver salt molecules and of the gelatin molecules at the interfaces where the silver grains and the gelatin are in contact. It is perhaps this molecular organization to which we must look for an explanation of the fact that once the silver salt molecules have been brought into the chemically active condition by the exposure of the plate to light they are able to remain in this activated condition until the plate is developed.

Similarly may we not suppose that certain substances in the blood stream and in the tissues of the plants, cottonseed oil, etc., may be chemically activated by ultra violet light so that a photo-

chemical product is formed that can only be developed when these substances have been brought into the places where they will initiate differentiation?

Physiologists have named substances like those contained in cod-liver oil which catalyze certain physiological processes "vitamins." The above considerations may throw a great deal of light upon the nature of vitamins. They seem to be substances with chemically activated atoms which are capable of hastening the speed of physiological changes so that they proceed at body temperatures and at velocities which would otherwise necessitate very much higher temperatures.

Undoubtedly there are numerous other chemical substances in the body about which we know nothing which help us materially in resisting disease. A child, for example, is deprived of the proper amount of sunlight. Certain chemical substances do not form and the child is unable to resist the inroads of disease, whether it be an ordinary cold, or tuberculosis as pictured by Rollier. By the scientific administration of this lacking sunlight, Rollier has been able to develop the resistive powers of the child against tuberculosis.

Whatever theories are proposed to explain the reactions, the fact remains that most plants and animals, including man, are as dependent upon the ultra violet energy of sunlight for normal growth and development as they are upon the heat energy of sunlight. Other physiological functions besides bone development are interfered with when the organism is deprived of this kind of radiation. The body is more susceptible to the inroads of disease. A well-sunned body furnishes a high degree of protection against tuberculosis, and the progress of the disease, even after it has been contracted, is often quickly and permanently checked. Window glass has unquestionably accelerated the speed of civilization, but man has paid the price.

THE DIFFERENTIAL DIAGNOSIS BETWEEN TUMORS AND TUBERCULOSIS OF THE LUNG

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OLD THEORY

Since Otten's pioneer work on the roentgen ray diagnosis of lung tumors, in which he expressed much confidence in the use of the rays for this purpose, a number of publications have appeared, which, while conceding to x ray diagnosis a more or less important place among clinical diagnostic methods, would still deprive it entirely of absolute diagnostic value. Isolated cases are even reported in which the x ray findings were absolutely misleading. Thus Silberstern and Singer, in a recent publication entitled, *On the Tumor-Like Appearance of Tuberculosis in the X Ray Picture*, describe several cases in which the roentgenographic findings were unquestionably indicative of a tumor while the clinical findings and the course of the disease proved them to be tuberculosis.

In the following discussion I wish to show that such mistakes in diagnosis can be frequently avoided if the proper evaluation is placed upon each separate roentgenographic finding, and in addition I would like to extend the field of usefulness of the roentgen ray by introducing several as yet little-known signs. Well known material shall be only lightly touched upon.

My discussion will be limited to the two lung conditions most commonly considered in a differential diagnosis, namely primary carcinoma and tuberculosis, and to chronic pneumonia which, because of its comparative rarity, presents greater diagnostic difficulties. Other conditions, as metastases and mediastinal tumors, which were included in the discussion by Silberstern and Singer, will not be touched upon because they have an entirely different symptomatology and require separate consideration.

Upon what findings, according to the publications previously mentioned, does the x ray diagnosis *lung tumor* depend? Since the acceptance of Otten's work the following triad has been considered characteristic of lung tumors:

1. Unilateral existence of the process.
2. Homogeneousness.
3. Possession by the questionable shadow of a sharply defined border.

Even Silberstern and Singer designate shadows with these characteristics as "tumor like." Let us place these three cardinal findings under the lupe of general roentgenology and attempt to determine the significance of each from a physico-anatomical standpoint.

UNILATERALNESS: That the finding of a pathological change in only one side of the lung cannot be used as an argument either for or against the presence of a

given disease process is well known, for there is hardly a thoracic disease which may not involve either one or both sides. That even advanced tuberculosis may involve only one side is better known today than ever before, since the production of an artificial pneumothorax hinges upon this point. It must be understood, of course, that the presence of an undoubted tuberculous process in one lung makes it more likely that an undetermined condition in the other lung is also tuberculosis, but this is by no means necessarily true. The fallacy of such an assumption will be shown by a case to be mentioned later, in which, on the basis of certain diagnostic points not yet discussed, we found a tumor in one side and tuberculosis in the other.

HOMOGENEITY: How does the second cardinal point of a tumor, *the homogeneousness of the shadow,* come about, and what does it signify? From a roentgenological standpoint, a shadow is considered homogeneous when there is an approximately equal absorption of light rays in all parts of its structure; that is, when all parts of a stratum or closely adjacent strata have the same specific gravity. If we disregard adipose tissue and lime salt deposits, the former of which need not be considered at all and the latter but little, then we have left only two media which behave differently with respect to the absorption of x rays: on one hand the air contained in the bronchial alveoli, cavities, and pleural spaces; on the other hand all normal or pathological structures. Be it a parenchymatous organ, a fluid substance (serum, blood, pus, etc.), an infiltration or tumor tissue, they are all alike with regard to their physical action on light rays. From this it follows that a shadow in the lung is homogeneous when its air content is uniformly distributed; or, it lacks homogeneity when portions containing no air are separated by other portions containing left over quantities of air or in which there is a pathological increase of gases. If we then carry this simple but fundamental fact over into the field of pathologic anatomy we conclude that all processes which replace lung tissue and all compact infiltrations will produce a homogeneous shadow. In the group of lung replacing processes belong the benign, cystic, and some malignant tumors; also collections of glands whether of tuberculous or other origin; and all processes which do not arise from the lung itself but from surrounding structures, as the pleura or mediastinum, and press upon the lung. In the group of compactly infiltrating diseases belong the larval pneumonias, some forms of tuberculosis, caseous and congestive pneumonia, and, finally, those malignant tumors which grow by infiltration. Nonhomogeneous shadows result only from irregular infiltration which usually results from tuberculosis, less often from lobular pneumonia, tumor metastases, or pneumoconiosis. We, therefore, come to the conclusion that *a spotted shadow of irregular density is usually indicative of tuberculosis rather than a tumor,* and that *a homogeneous shadow is in no wise a proof of the presence of a tumor,* but occurs in many different kinds of processes

including tumors and some forms of tuberculosis.

Definiteness: Let us now turn to the third of those cardinal findings which are supposed to typify tumors: the sharp border of the shadow. A lung shadow can have a sharp margin only when the circumscribed pathological process which produces it borders throughout its whole extent upon entirely normal, air-containing lung tissue. Indistinct outlines occur when the air content of the lung surrounding the pathological area increases gradually from zero to the normal. The requirements for producing a sharp border are satisfied by neighboring pathological processes which press upon the lung, such as mediastinal, pleural, and interlobar diseases, so long as they are separated from the lung tissue itself by an intact pleura. (Atelectasis produced by neighboring tumors and effusions practically always results in a distinct border.) Furthermore, sharp borders are shown by all lung tissue substituting processes which are enclosed in a capsule, such as cysts, benign and malignant lymph node tumors, all completely healed areas enclosed in a connective tissue capsule, and healed tuberculosis. An indistinct outline accompanies infiltrating processes so long as they have not reached a natural barrier, as thoracic wall, mediastinum, and, most important of all, an interlobar septum.

When considered from this gross anatomical standpoint, what findings are presented by the diseases which interest us here: (1) bronchial carcinomas and the two conditions which most often require to be separated from them in a differential diagnosis, (2) tuberculosis, and, (3) pneumonia. Since Otten's time the bronchial carcinomas are divided into two main groups, the hilus carcinomas and the lobar carcinomas. In my experience the latter are much more common than the former. The hilus carcinomas arise quite obviously from one of the principal bronchi and grow outward uniformly in all directions into the surrounding lung tissue. The lobar carcinomas arise from a large or small bronchus and grow without restraint in the affected lobe until they reach the interlobar pleura; here they are usually held in check for a long time. From the above statements it is evident that the hilus carcinomas must always have an indistinct border, while tumors and tuberculosis involving the lymph nodes in the hilus region have a sharply defined border, as has previously been shown. This is just the reverse of the diagnostic point mentioned at the beginning of this discussion. Lobar carcinomas become entirely surrounded by a sharp border when they fill a whole lobe of the lung, or become sharp on one side when they reach the margin of the lobe. They then present themselves under the picture of the so-called *lung border infiltration,* which is precisely what the sharp border indicates.

We have known since the classical work of Fleischner on *Lobar and Interlobar Lung Processes* that this kind of a lung border infiltration occurs in a number of different diseases, especially in

those which concern us here in a differential way. Aside from the lung carcinomas just mentioned, this type of infiltration of the lung borders may be produced by some forms of tuberculosis, as the so-called cortical phthisis, the caseous and congestive pneumonias following tuberculosis, and also very frequently genuine pneumonia. The early inflammation which the internist designates as central pneumonia practically always begins along the border or in the apex of a lobe. I shall cite three examples of lung border infiltration occurring in different diseases.

Case No. 1: B. F., 55 years old, female. *X ray findings*: A band of shadow of about one hand's breadth in the center of the pulmonic field, had an indistinct upper border while the rest was sharp and corresponded to the margin of the upper lobe. We are dealing here with a bronchial carcinoma. (Fig. 1.)

Fig 1.—Border of upper lobe—Infiltration in bronchial carcinoma.

Case No. 2: A. R., female, 24 years old. *X ray findings*: Homogeneous clouding of the base of the upper lobe, sharply defined at the border of the lobe. A case of tuberculosis was found here. (Fig. 2.)

Fig. 2.—Border of upper lobe—Infiltration in tuberculosis.

Case No. 3: A. P., male, age 40 years: *X ray findings*: A homogeneous shadow in the middle of the pulmonic field, with a sharp, linear, upper border. In this case we have a pneumonia of the upper half of the right lower lobe. (Fig. 3.)

The author believes to have found, through investigations carried on jointly with Haslinger, an explanation of this predilection for the lung borders exhibited by infiltrative processes of various origins. It has been shown on introducing opaque fluid substances into the lung that these frequently flow against gravity and tend especially to flow toward the lung borders. I shall demonstrate this by the following three examples:

Case No. 4: H. K., female, 24 years old. *Clinical diagnosis*: Bronchiectasis. *X ray diagnosis*: The bronchus of the lower lobe was entered with Haslinger's hollow sound and 5 c. c. of lipiodol was

Fig. 3.—Border of lower lobe—Infiltration in penu-penumonia.

injected through it. The greater part has long since gathered at the fissure between the lower and middle lobes.

Case No. 5: M. B., male, aged 63 years. *Clinical diagnosis*: Bronchiectasis. *X ray diagnosis*: The bronchus of the right middle lobe is being sounded and lipiodol is being injected. The greater part of it is gathering at the fissure between the middle and lower lobes.

Case No. 6: Lung of a cadaver in an embalmed trunk in the upright position. The investigation was conducted in the anatomical institute of Professor Fandler, and with the co-operation of the assistant, Dr. Goldhamer. A bronchoscope was introduced down to the opening of the right main bronchus and then jodipin was injected. It flowed visibly, against gravity, along the border between the middle and lower lobes which was well marked by a collection of air.

From these investigations we conclude that *the lung borders clearly possess an especially good connection with the outside world*, and that *on physiological grounds they are manifestly well ventilated*. This also explains the frequency of lung border infiltrations.

We have therefore seen that bronchial carcinomas are sharply marked off only when they have reached the border of a lobe, and that the widest variety of other lung processes, including tuberculosis, may frequently show a sharp contour for the same reason. Thus this third cardinal finding is far from possessing any pathognomonic significance.

Summing up what has been said we must conclude that the triad of unilateralness, homogeneousness, and sharp contour signify nothing more than the presence of certain gross anatomical and roentgenologicaly characteristic changes. None of these findings are derived from that characteristic of the tumor which distinguishes it anatomically and biologically from other processes, namely, its malignancy. The substance producing a shadow which is characterized by the triad we have mentioned may be a tumor, but is not necessarily so. Just those diseases which must be considered in a differential diagnosis frequently show the same gross physico-anatomical appearance. And on the other hand, as has been shown, a lung tumor may not always sat-

isfy the requirements of this syndrome. The accompanying picture combines all three findings in a most typical way and still it is not a tumor but a sacculated interlobar empyema.

NEW THEORY

If the roentgenological possibilities were exhausted with the consideration of the three cardinal findings which have been mentioned, then we would be forced to admit that the findings were really capable of demonstrating nothing more than the unliklihood, possibility, or probability of the presence of a tumor. A definite answer could be given in no case except after clinical investigation, observing the further course of the disease, or perhaps only after the case had gone to autopsy.

Even though this is sometimes actually the case, I now wish to show that in not a few cases the x rays are in a position to do more, in as much as they are still capable of bringing up several weighty arguments for or against the assumption that one of the diseases we have been considering is present. These arguments are at least partly based on the malignancy of the process. Not infrequently do they uncover undoubted signs of one disease or another. Therefore, several known but little appreciated or incorrectly interpreted signs, and several as yet practically unknown x ray findings will be described.

I would like to remind you of the frequent occurrence in x ray pictures of the narrowing of a main bronchus due to the so-called *wandering of the mediastinum* which results from suction exerted on the mediastinum by the diseased side (Holzknecht-Jakobson's phenomenon.) By far the most common cause of this stenosis of the bronchus is bronchial carcinoma. In one case, which will be brought up later in which there were no evident signs of a lung tumor our suspicions were directed toward a small bronchial carcinoma by this finding.

One characteristic of tumors which occasionally has definite diagnostic value is their aggressiveness, their boundless reaching out into neighboring parts. That this can become manifest from a roentgenological standpoint is illustrated by the following case:

Case No. 7: P. H., a male patient 45 years old. *Clinically*: He was referred to us as an ambulatory patient without anamnesis or clinical findings. *X ray findings*: The right upper pulmonic field showed a dense, homogeneous shadow, the lower border of the shadow at about the level of the fourth rib being sharp and crescentic. The right side of the diaphragm is about a handbreadth higher than the left, but is normally arched and the phrenico-costal sinus is preserved. Although this condition of the diaphragm alone indicated a paralysis of the phrenic, the opinion was confirmed by the paradoxical movement on inspiration and, even more so, by Miller's test. (Fig. 7.)

We have here, then, a right sided paralysis of the phrenic in addition to the questionable shadow in the right up-

per lobe. Manifestly, the process penetrated through its pleural covering and involved the phrenic either directly or by metastases. Both assumptions are of significance from the standpoint of malignancy.

Most publications on this subject convey a somewhat incorrect conception of the contraction and compression findings. It is undoubtedly true that lung tumors sometimes lead to a pleuritis which has a tendency toward contraction, but at most this tendency manifests itself as a moderate narrowing of the intercostal spaces, for it is largely compensated by the expansive growth of the tumor. I have never seen high degrees of displacement of the mediastinum toward the diseased side in bronchial carcinomas, but on the contrary there is occasionally a small amount of displacement toward the sound side. Just how important it may be in the diagnosis to note the relation of neighboring organs to the questionable shadow is illustrated by the following instructive case which I demonstrated before the Association of Roentgenologists of Vienna during the past year:

Case No. 8: J. P., a male patient 57 years old. *Clinically*: Was sent to us from the II Medical Clinic for x ray therapy. *X ray findings*: He showed evidence of obstruction in the distribution of the superior vena cava (venous dilation and edema of the upper half of the body.) Summary of the x ray findings: Homogeneous clouding of the right upper pulmonic field, sharply bordered at the edge of the lobe. Right-sided phrenic paralysis. These, as well as the clinical evidences of obstruction, point toward aggressiveness: therefore, malignancy; while the apparent infiltration of the whole lobe speaks for a bronchial carcinoma. On the left side is revealed an area of increased density composed of stripes having a net-like arrangement. The question is, do we have a lymph angiectatic carcinnomatosis or a fibrous phthisis on this side? But in addition to the above there is an evident displacement of the trachea toward the left. This

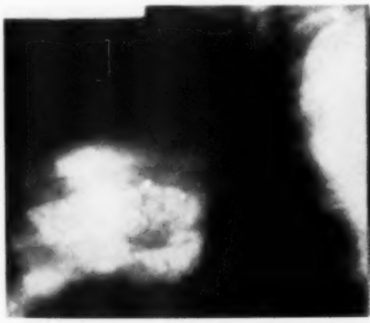
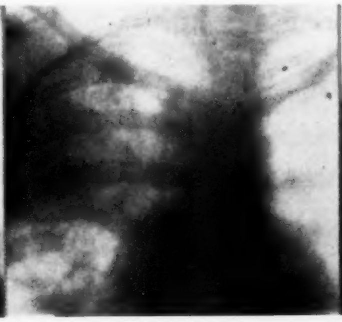
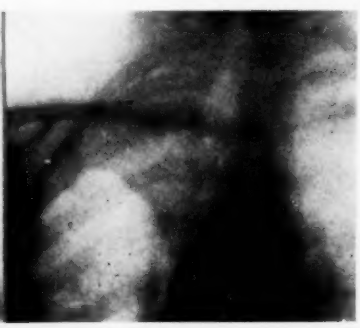




Fig. 4.—Infiltration of the right upper lobe with paralysis of the phrenic (bronchial carcinoma).

Fig. 5.—Tumor of the right upper lobe; fibrous process in left upper lobe (contracting tuberculosis), shown by the trachea being drawn out of position and having a circumscribed dilatation.

Fig. 6.—Infiltration of the right upper lobe, with the border of the lobe abnormally high and abnormally concave (tuberculosis).

might result from pressure produced by the tumor on the right, or from a contracting process on the left. It is to be noted, however, that in addition to the displacement there is a dilatation of the trachea, its left wall presenting a marked convexity toward the left. This is positive proof that we are not dealing with a pressure affair, for that would cause a narrowing of the trachea; instead, it must be due to traction. Fleischner was the first to describe this condition of dilatation of the trachea as an interesting accompaniment of traction displacement. Such a finding in this case assumes a position of the greatest importance from the standpoint of the differential diagnosis. Basing my opinion on this evidence I came to the conclusion that on the left side there was an old contracting tuberculosis. Our diagnosis was fully borne out at autopsy, for on the right was found a bronchial carcinoma with infiltration of the phrenic nerve, while on the left was an old fibrous phthisis. (Fig. 5.)

Contraction on the one hand as opposed to expansive growth on the other may influence the form and position of the border of the involved lobe in a very characteristic manner, which, then, offers valuable aid in the diagnosis. I would like to illustrate this point by means of two characteristic cases.

Case No. 9: A. K., male, aged 28 years. *Clinical Diagnosis*: Infiltration of both apices. *X ray findings*: Homogeneous darkening of the right upper pulmonic field with a sharp lobar border, which is abnormally high, being at the level of the second rib anteriorly (normally the fourth rib). It also shows an abnormally marked downward concavity. In addition there is a traction displacement of the dilated trachea toward the right. We have, then, considerable contraction of the whole lobe, which speaks decidedly against the presence of a tumor and for tuberculosis. (Fig. 6.)

Case No. 10: B. P., male, aged 56 years. *Clinically*: Has had difficulty in

Fig. 7.—Infiltration of the upper lobe, with lowering and convexity of the lung border (tumor).

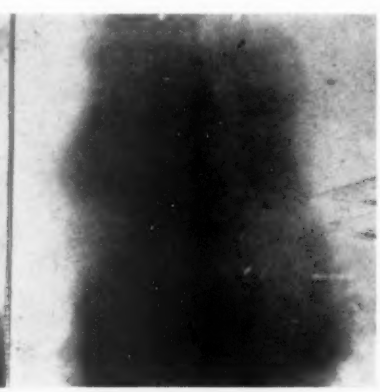


Fig. 8.—Mediastinal tumor whose left lower border is indistinct and jagged, indicating that it has broken through the pleura (malignant process).

breathing for several weeks. Clinically, there is dulness in the right upper thorax. *X ray findings*: Homogeneous darkening of the right upper lobe. The border of the lobe is somewhat lower than normal and shows only a slight convexity inferiorly. This is good evidence of the expansive growth of the process: therefore, a tumor. (Fig. 7.)

The malignant character of a lobar involvement sometimes expresses itself in the course of the disease by infiltrating and destroying the interlobar pleura and breaking into the adjacent lobe. This occurrence is recognized from a roentgenological standpoint, as follows from the previous discussion of the causes of sharp and poorly defined borders, when the otherwise sharp border of the lobe becomes distinctly ragged at the point where the growth broke through. Unfortunately, I do not have an appropriate photograph to show this occurrence with a bronchial carcinoma, but will show an analogous case of a mediastinal tumor.

CASE NO. 11: A. P., a female patient, aged 30 years. *X ray findings*: *Marked* widening of the entire medial shadow, with a sharp, wavy contour except in the left lower part where the border is indistinct, ragged and shows processes extending out into the light lung area. In this case the tumor broke through the pleura into the lung. (Fig. 8.)

We see, therefore, from the conditions shown, and in opposition to the generally accepted view, that *it is the indistinctness of certain portions of the border which proves the malignancy of questionable tumors.*

Before I take up the last and most important of the diagnostic evidences of tumor I wish to say that in our experience the therapeutic use of the x rays sometimes gives far- reaching information regarding the nature of the lung process under consideration. The biological result affords us a view into the biology of the disease in question and in this way may give some indication of its anatomical character. I mention this biological result because it has proven itself, though indirectly so, an important, roentgenologically diagnostic point. Borak and the author reported in detail on the diagnostic value of the effects of roentgen rays about a year ago. We found the following three groups of ray-effects, as well as combinations of them, of value in the diagnosis of various diseass:

1. The local changes in the pathological tissue produced by roentgen rays.

2. The generalized effects produced by absorption of the products of degeneration.

3. The secretory products appearing after exposure.

The last named effect plays no role in the diagnosis of lung diseases with the exception of melanosarcomas which do not interest us here. The meaning of the first effect, the occurrence of local changes, becomes evident when one considers the following: Bronchial carcinomas are practically refractory to x

rays; sarcomas can sometimes be rapidly reduced by irradiation; chronic penumonias tend to be reabsorbed rapidly after irradiation; occasionally , in certain cases of tuberculosis which cannot be designated in detail here, there is a gradual beneficial influence, but complete healing is not accompanied by a marked reduction in the roentgenologically demonstrable changes.

Of the second class of effects, the general reactions, the one most interesting to us is fever. Accessions of temperature following irradiation occur when there is rapid breaking down of a tissue which is very sensitive to x rays, secondly when there is a liberation into the circulatory system of specific products having a temperature raising action, and most of all the exposure of tuberculous lung tissue to x rays. One cannot go more deeply into this important subject as yet. To do so would require a search through a large mass of material such as we do not have at our disposal in order to determine whether or not test irradiations can take a place longside test injections of tuberculin. I shall reproduce here a characteristic temperature curve following exposure of a tuberculous lung to x rays.

One day after every irradiation of the lungs we find a characteristic peak directed upward, while the alternating irradiations of the cervical lymph nodes do not show this effect.

Combining the effects of irradiation which have been described results in the following possibilities in the diagnosis of lung diseases:

1. Fever following the exposure and rapid diminution of the questionable shadow; the irradiated tissue was probably a sarcoma.

2. Fever, but no demonstrable change in the shadow; one is most likely dealing with tuberculosis.

3. No fever, and the shadow fades away; this is most frequently found in a chronic or secondary pneumonic process.

4. No fever, and no change in the shadow; it may be a carcinoma of rather benign type.

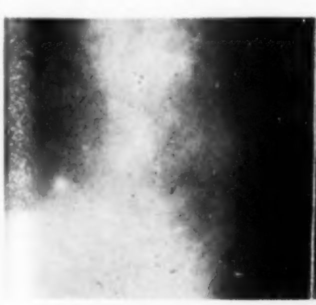
In the following case I wish to show the practicalness of the effects of irradiation in the diagnosis of even complicated processes.

Case No. 12: R. P., male, aged 51 years. *Clinically*: Referred (by the II Medical Clinic) with the diagnosis of lung tumor. Difficult breathing, hemoptysis, venous dilation, cyanosis and swelling of the right upper half of the body.

X Ray Findings: In the right upper pulmonic field there is a shadow the size of half of an apple with its broad base directed toward the thoracic wall. Because of this last characteristic it must be designated as a pleural process. A triangular shadow having all the signs of a lung border infiltration extends outward from the hilus and involves the first

shadows somewhat. (Fig. 9.) If one seeks to correlate these findings, then the infiltration must be regarded as primary and the pleural shadow can be nothing else but a sacculated exudate. This conclusion proved to be right: a puncture at the site we recommended yielded an exudate, a part of which was aspirated. (Fig. 10.) The nature of the lung border infiltration remained to be determined; a genuine pneumonia was ruled out by the clinical findings. Tuberculosis and a bronchial carcinnoma needed to be considered. The use of x rays now produced, without any reactive rise of temperature, a gradual clearing up of the lung down to a small three-cornered residuum in the hilus and a narrow streak corresponding to the border between the upper and middle lobes (Fig. 11). The failure of local and general reactions to appear excluded tuberculosis. Speaking against carcinoma was the good influence exerted by the x rays, almost to the point of disappearance of the process, and the fact that in place of the former shadow an entirely normal lung tissue was now to be formed. This indicated that the basis of the shadow was an infiltrating pneumonic process rather than one of a destructively growing, lung tissue substituting character. We were almost compelled to draw the conclusion that we were dealing with a small bronchial carcinoma which was accompanied by a secondary pneumonia in the corresponding portion of the lung, a complication of bronchial carcinoma which is not infrequent and is difficult to diagnose clinically. The autopsy which was performed a number of months later confirmed the diagnosis in all details. There was a small carcinoma in the main bronchus, the base of the right upper lobe was somewhat richer in pigment than the rest of the lung, while only an interlobar thickening between the upper and middle lobes gave evidence of the inflammatory process which had been active here.

The last and most certain means at our disposal in the recognition of bronchial carcinomas is the diagnostic practice of filling the bronchi with a comparatively opaque substance. Haslinger, Presser have, as we recently reported on two cases before the Medical Society of



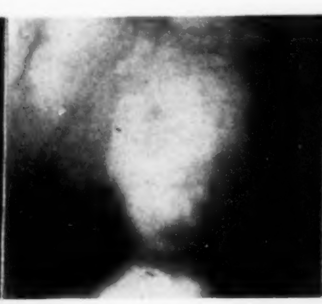


Fig. 9.—Infiltration at the base of the right upper lobe bronchial carcinoma plus secondary pneumonia) with a stationary, sacculated pleural exudate.

Fig 10.—The same case after partial removal of the exudate.

Fig. 11.—The same case three weeks after irradiation.

Vienna, extended this method, which was previously used almost exclusively in cases of bronchiectasis, to the diagnosis of bronchial tumors. Glogauer, working independently of us, has since then reported a similar case. A consideration of the pathological anatomy and the pathobiology of malignant tumors, most of all their method of local extension, yields the following possibilities for the purposes of this treatise. Tumors in a large bronchus must lead to a stasis of the opaque material, as well as showing the atypical filling defects with which we are familiar from the diagnosis of stomac hconditions. With the proper technique, which cannot be discussd here, proof of their presence must result in a large percentage of cases, for corresponding statistics have shown that a third of all carcinomas are located in a main bronchus, and according to Aschoff they always arise in a bronchus of the first to the third order. As has already been said, the specific method of extension of a malignant tumor is also of importance. It either grows in directly and displaces the lung tissue, or extends in an infiltrative destructive manner, while in those disease processes which are concerned in a differential diagnosis, namely penumonia and those forms of tuberculosis previously mentioned (cases in which there is a massive infiltration without disintegration, in reality a prolonged infiltration of an exudative character and caseous pneumonia), destruction is lacking or takes a very minor position compared to the pure infiltration, or better, the exudation. The result is that on filling the bronchi with an opaque substance there is a complete or nearly complete disappearance of the bronchial tree within the limits of the questionable shadow if it is a malignant process, while the bronchial passages remain patent for the most part if it is an infiltrative process. To what extent these theoretical assumptions will be borne out in practice must be determined by experience. In two of our cases they displayed merit. These we showed and reported in detail before the Medical Association of Vienna, and published them under progress in the field of roentgenology. I shall repeat only an extract of the roentgenological findings.

CASE NO. 13: E. K., a female patent, 52 years old, and referred from Prof. Hajeck's clinic. Both pulmonic fields dotted with spots of a tumor metastasis type. The lower half of the right pulmonic field was homogeneously clouded. This part of the lung does not become filled with jodipin at all following injection of this substance into the trachea, the bifurcation shows a semicircular curve instead of the normal angle, and the proximal ends of both main bronchi are narrowed and jagged. (Fig. 12.) Diagnosis: Tumor metastases in the lung, spreading of the bifurcation by metastatic growths in the lymph nodes which have also broken into both main bronchi. Post-mortem examination revealed a massive tumor infiltration in the lower right portion of the lung, abundant metastases scattered throughout the whole lung, and a collection of involved lymph nodes at the bifurcation with pene-

tration into the main bronchi. The anatomical preparation was like a cast of the x ray picture.

Case No. 14: A. F., a male patient 44 years old. *Clinically*: There was no suspicion of a tumor. *X ray findings*: Illumination with the roentgen rays showed a uniform clouding of the left upper pulmonic field and a drawing of the mediastinum toward the left by suction on inspiration. This awakened a suspicion of bronchial stenosis. After injecting jodipin: An occluding stenosis of the left main bronchus, a conical diminution of the same with sharp borders, and also a typical filling defect. Diagnosis: Carcinoma of the left main bronchus. (Fig. 13.)

We see, then, that in this method of filling the lungs with an opaque substance, we have in our hands a means of the greatest importance in furthering the differential diagnosis we have been considering; a means which may give absolutely certain direct evidence, the dignity of which is equal to that of the niche in gastric ulcers.

SUMMARY

1. The commonly accepted triad of characteristics common to lung tumors, unilateralness, homogeneousness and sharpness of the shadow outline is ambiguous. This is not to be wondered at, for this complex is only evidence of certain gross anatomical conditions which are frequently found in tumors but not necessarily so, and which often occur in other affections. The most important characteristics of malignant tumors, their aggressiveness and their substituting and destroying growth, find no expression in this triad.

2. There are several as yet little known and little noted findings which are capable of aiding the diagnosis because they are derived at least in part from the malignancy of the tumor, its expansive, infiltrating, destructive growth.

Fig. 12.—Iodipin injection. Metastatic tumor in the lymph-nodes at the bifurcation which has broken through into the bronchi, diagnosed from the picture taken of the injection and confirmed at autopsy.

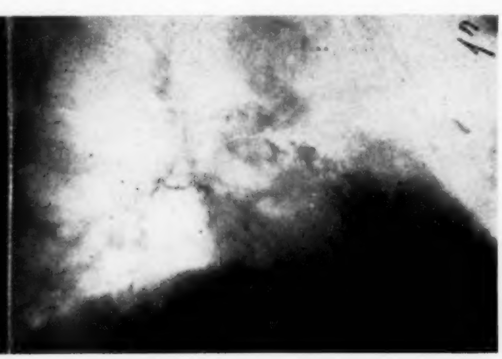


Fig. 13.—Iodipin injection. Stenosis of the left main bronchus, jagged termination of the injected material (bronchial carcinoma).

3. Furthermore, the effect of trial irradiation with local and general changes when viewed in the light of our knowledge of the biological effects of irradiation permit one to draw some inference regarding the nature of the underlying process.

4. The filling of the bronchi with an opaque substance has occasionally given us pictures bearing undoubted evidence of lung tumor. Their symptomatology must be derived from the special anatomy of the lung process.

In many cases, of course, the diagnosis can be made only on the basis of clinical findings. But in many other cases, long before the disease has run its course or the autopsy findings have given conclusive evidence, a thorough roentgenological examination will clear up the diagnosis.

Vienna IX, Boltzmanngasse 22.

TREATMENT OF INDUSTRIAL DISEASES WITH PHYSIOTHERAPY*

E. C. Duval, M. D.
Chicago, Ill.

When we speak of physiotherapy we mean, of course, the physical means that are used to promote the well-being of the patient, without the intervention of surgery and the administration of drugs. Among the modalities used in this form of treatment we may mention ultra violet ray, diathermy, radiant lamp, infra red rays, hydrotherapy, galvanism and one of great importance, massage. All these modalities are used, some more frequently than others, and all have their indications for use and also their contraindications. It is essentially necessary that the person who gives physiotherapeutic treatment be thoroughly trained in the application of the various modalities and if he is not a physician, he should be under the direct supervision of one who will prescribe the modality and the dosage to be given. Simple as they may seem in their mode of application, some of these forms of treatment are dangerous when carelessly undertaken.

You would not allow a careless or untrained technician to give an x ray treatment or exposure to the actinic ray, for fear of the great damage that is possible to occur to your patient and it is just as necessary to be careful with all other modalities.

To be successful in administering physiotherapy, one must be thoroughly cognizant of the nature and extent of the pathology existing before instituting treatment and this knowledge should be ascertained by clinical examination, x

*Read before the fourth annual meeting of the American College of Physical Therapy, Chicago, October 19, 1925.

ray and laboratory tests, if they are indicated. It is not good policy and not good medical practice to omit anything that might give light towards a correct diagnosis, as something may be overlooked, the existence of which may be a potent factor in the prolongation of the patient's disability and which later may be discovered by another examining physician, with consequent loss of prestige to the first doctor. A correct diagnosis must be made before instituting physiotherapeutic treatment, as a correct diagnosis must be made before instituting any form of treatment that is to end with success. We may add to this, that one of the best attributes that a successful physiotherapist has is the ability to determine if the treatment is indicated at all. Unfortunately, there have been many instances where treatment has been given in hopeless cases, that is to say, cases reasonably beyond the hope of benefit by any form of treatment. That is a bad practice and it should not exist, as it brings into disrepute an adjuvant to general medicine that is really meritorious.

During the past few years physiotherapy has become a factor in the treatment of industrial cases. Its economic value has become an established fact and insurance carriers are today requiring the services of physiotherapists to a much greater extent than formerly, realizing that by the institution of this form of treatment, disabilities are in most cases more or less reduced, resulting in a material saving of compensation that would otherwise be paid to the working man. Aside from the saving that accrues to the insurance company, there is the great benefit of a speedier recovery for the working man, enabling him to return that much earlier to the capacity of bread winner for his family.

In large industrial centers the working man is more or less liable to be the victim of almost every conceivable form of injury and in the wake of severe injuries, there are, of course, certain sequelae to be treated and these sequelae are very often quite amenable to physiotherapy.

It is not the intention to go into the method of application of each one of the various modes of physiotherapy or the indications for their use, for that would be impossible in so short a paper, but perhaps we can treat on this point broadly, so that we can get an idea as to the economic value of physiotherapy and some of the results that have been obtained by its use in the field of Industrial Medicine and we might say in passing, that there is no field that affords greater opportunity for the use of physiotherapeutic measures.

In mentioning some of the types of cases that are favorably influenced by physiotherapy, we might include infections, ununited fractures, fractures with delayed union, sprains of the ankle and back sprains, nerve injuries, synovitis and bursitis, pseudo-ankylosis, osteomylitis, limitation of functional movement of a joint, after a period of immobilization and the sequelae of dislocations. There is no doubt of obtaining good re-

sults in all of these types of cases, if physiotherapy is properly administered.

INFECTIONS

Infections have been successfully combatted with the aid of the ultra violet and radiant light lamps. In Industrial Medicine we have, of course, many hand infections where, in quite a few instances, the infection set in after a comparatively slight injury, with a small abrasion of the skin, and the patient was not sent to the surgeon until after the successful invasion of the affected tissues by the bacterium causing the infection. Insurance statistics will show that practically every industrial surgeon has had experience with this sort of case. When the patient presents himself at your office, suffering with such a condition, it is good procedure to cleanse the infected part as well as possible, following this with an exposure to the quartz lamp and then the application of diathermy. The bacteriacidal effect of the ultra violet ray and the increased phagocytic action of the blood by diathermy will, in twenty-four hours, produce a remarkable change for the better. By this method you will preclude the possibility of the formation of the mass of adhesions and other sequelae usually attendant upon infections. The aftermath of infectious processes that have prevailed for a considerable period of time, are best treated by diathermy, followed by massage and manipulations.

FRACTURES

Ununited fractures and fractures with insufficient callus to form a solid union, in most cases respond very well to treatment by diathermy, followed by massage in the degree indicated. Some cases will not allow of vigorous massage at the commencement of the treatment, therefore, massage must be given lightly first and gradually increased to more vigorous treatment.

INJURY

An injury that is quite common is the ankle sprain. Instead of immobilizing the ankle with adhesive straps as is usually done, begin treatment with hot or cold applications, whichever will make the patient more comfortable, for the first twelve to twenty-four hours. Then apply diathermy, following the application by gentle massage and the result will be gratifying both to yourself and the patient. You will perceive that the swelling and discoloration that usually appears from the fourth to as late as the sixth day after the injury, will be practically absent. There will be very little, if any, impairment of the functional movement of the joint and the period of disability is very materially shortened.

STRAINS

Strains of the back muscles constitute another common form of injury, occurring usually in the heavy muscled individual. It rarely needs more than four or five treatments to overcome ths condition, if physiotherapy is instituted shortly after the patient is injured. The writer of this paper recalls to mind a case where the injured man had his back strapped several times, over a period of

five weeks and after the adhesive straps were removed the last time, the right latissimus dorsi was quite rigid. This rigidity extended from about the third lumbar up to about the tenth thoracic vertebrae and well over to the mid-axillary line. Pressure on the muscle caused the patient pain. In treatment of this case, massage was first used, but it was so painful to the patient that it was stopped after the first few minutes and diathermy was given for about one hour. Massage was again instituted immediately after the application of the diathermy and this time it was tolerated much better. After nine treatments by this method, there was not a trace of tenseness or rigidity left in the muscle. The opinion is advanced that the strapping of the back in this case, immobilizing the affected muscle for such a long period of time, only tended to keep it rigid, obviating the possibility of its functioning even to that small extent that would help Nature to overcome the condition.

SYNOVITIS AND BURSITIS

Synovitis and bursitis are sometimes effectively treated by diathermy, when other forms of treatment have failed to produce results. Especially is this true of synovitis of the knee joint. The application of an electrode on the anterior surface of the thigh, about three inches above the superior border of the patella, and another electrode on the calf of the leg, just below the popliteal space, will, in about ten minutes, with a milliamperage of 600 to 700, diffuse a very comfortable heat in and around the joint. This, followed by the form of massage known as effleurage, which consists of stroking the part in the direction of the venous return, will cause an absorption of the extravasated fluid. After the treatment, the patient should be supplied with an elastic roller bandage, the application of which will support the tissues, preventing, to a certain extent, their subsequent infiltration with fluid. The roller bandage is preferable to an elastic stocking, as its tension on the part can be comfortably adjusted by the patient.

OSTEOMYELITIS

Osteomylitis is another condition not infrequently occurring after fracture cases in the industrial field, and it is not necessary to say to you that it is a most stubborn disease. Recent research done on a series of cases (five in number) produced such results that it is not too much to say that a great deal can be expected from treatment of this disease with the quartz lamp and diathermy. The data on these cases is not yet complete and cannot, therefore, be presented at this time, but will be when all the facts can be presented in a scientific manner.

However, this much can be said about the treatment, based on the results obtained: After the surgeon has operated the case for removal of sequestrum or some necrotic tissue or the destruction of the bone abscess, the patient should, as soon as consistent, be sent to the physiotherapeutic department of the hospital. There the dressing should be removed

and an exposure, at a distance of 24 inches from the quartz lamp, should be given. Immediately following, diathermy should be applied for at least one hour, with a milliamperage not exceeding 600. The affected part should then be antiseptically dressed and properly supported and the patient returned to his room. The treatment should be repeated daily. In a short time it will become quite apparent that the progress of the bone destroying process is arrested. The surrounding soft tissues are less swollen and edematous. The foul odor, that usually emanates from such a condition, is almost entirely absent and the deep discoloration of the external tissues gradually gives way to a healthier looking color.

This treatment, as outlined, is respectfully submitted with the idea that it may be an incentive for some of you to do some work along the same line, when the opportunity presents itself and at a later meeting, through an exchange of ideas, we may gain knowledge that will materially help us to more efficiently combat this troublesome disease.

The advances made in the treatment of industrial cases by physiotherapy have been very great in the last five or six years, but there is still considerable room for further research work and investigation of modalities that we have at our hand today, to determine their best possibilities and, as we proceed with our research and investigation, we will undoubtedly solve many problems that are troublesome today and by so doing lighten our burden as industrial surgeons, making our work more efficient and consequently more successful and put ourselves in line to do what the medical profession is ever ready to do—the accomplishment of something for the betterment of suffering humanity.

DISCUSSION

Dr. Frank H. Walke (Shreveport, La.): It has been my pleasure to know Dr. Duval for the last four or five years and to have followed his work and to have seen his results. I will say that Dr. Duval can do anything he says he can do. He is enthusiastic along the line of physiotherapy, but he is very guarded in his diagnosis and his prognosis in regard to such cases.

I have been very much interested in his osteomyelitis cases. I have been with him the last two days and have seen the treatment and the results in these cases of which he has spoken. They are extremely gratifying, and I think that we can learn a great deal from Dr. Duval's suggestion that diathermy along with the ultra violet light in the treatment of such cases will do much. They seem to have healed without much scar tissue. The skin around the ulceration is smooth and pliable in these cases, and it is extremely gratifying to know that function has been well maintained after this treatment.

I wish to congratulate Dr. Duval on his paper, for he has been doing a wonderful work along this line.

Dr. G. A. Larsen (Hayward, Wis.): The Doctor said that he used the quartz lamp at a distance of 24 inches. I would like to ask him if the time of his exposure at the beginning is 24 inches and if he increases and how much.

Dr. T. T. Gibson (Middlesboro, Ky.): I am glad to know that others are working along the same lines that I am working in the coal fields. For some few years I have been working in that manner, and I have been getting very gratifying results.

Dr. J. S. Coulter (Chicago, Ill.): I have had some experiences along these lines, and I want to corroborate all that Dr. Duval has said, and especially to emphasize diathermy in two of the treatments about which he spoke, sprains and bursitis. I have seen some of the very best results obtained in those two conditions.

In the treatment of osteomyelitis I think it ought to be emphasized, as Dr. Duval said, that any dead bone must be removed before you use diathermy or ultra violet light. The best way to remove dead bone, of course, is with a sharp chisel and a hammer, and then use your diathermy or ultra violet light and you will get just as gratifying results as Dr. Duval cited. I have seen such results in four or five cases that I can thnk of offhand.

Dr. E. C. Duval: With reference to the question asked about the length of exposure with the ultra violet light, the first exposure I usually give about one minute, and each exposure after that the time is increased just one-half minute until we have gone as high as fifteen minutes at a session. I do not care to go over that period of time, for two reasons: (1) I think when you reach that period of time you are getting about all that you can get from the ultra violet in such conditions as you are treating, and (2) time is a great factor in a physician's life when things are nonessential. When you treat a case over a period of time ranging from an hour to an hour and a half, you are doing something for that patient. However, I find that fifteen minutes' exposure as a maximum amount is best, commencing with the minute at the first exposure.

EDITORIAL

ARCHIVES OF PHYSICAL THERAPY, X-RAY, RADIUM

A Journal of Ideas and Ideals.

A. R. HOLLENDER, M. D., Editor
ALBERT F. TYLER, M. D., Managing Editor

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RULES GOVERNING THE READING OF PAPERS AND DISCUSSIONS

No address or paper before the College shall occupy more than twenty minutes in its delivery (addresses of specially invited guests excepted) and no member shall speak more than five minutes nor more than one time on any subject, provided each essayist be allowed ten minutes in which to close the discussion.

All papers read before the College shall be the property of the College for publication in the official journal. Each paper shall be deposited with the secretary when read.

No paper shall be published except upon recommendation of the Publication Committee, which shall consist of the Editor as chairman and other duly appointed members of the College.

The General Headquarters of the Clinical Congress of Physical Therapy will be located at the Drake Hotel, where all matters pertaining to the meeting will be cared for.

The Information Bureau and Clinical Congress Post Office are in connection with the Registration Bureau.

Please Register Before Attending Sessions

Bring Your A. M. A. Cards

PROGRAM
Monday, October 18

MORNING

8:00 Registration. Formal organization of classes

9:00 Galvanism, General Principles
J. U. GIESEY, M. D. .... Salt Lake City

9:50 Biophysics of Ultraviolet Light
ALBERT BACHEM, Ph. D. .... Chicago
University of Illinois College of Medicine

10:40 Physics and Uses of High Frequency Currents
W. B. CHAPMAN, M. D. .... Carthage, Mo.

11:20 Sine Currents
FREDERICK G. MORSE, M. D., Boston

Luncheon

Round Table Talks

Informal Discussions

AFTERNOON

2:00 Radium Therapy
A. F. Tyler, M. D. Omaha

2:45 X-Ray Therapy
Roy W. Fouts, M. D. Omaha

3:45 Medical Diathermy
Disraeli Kobak, M. D. Chicago

4:45 Industrial Physical Therapy
John Stanley Coulter, M. D., Chicago

EVENING

7:30 Principles in Surgical Diathermy Technic
Gustav Kolischer, M. D. Chicago

8:40 Physical Therapy
Franz Nagelschmidt, Dr. Med., Berlin

Tuesday, October 19

MORNING

9:00 Light Therapy in Pediatrics
I. L. Sherry, M. D. Chicago

9:50 Physical Agents in Gynecology
A. David Willmoth, M. D., Louisville

10:35 Treatment of Penumonia
Lloyd M. Otis, M. D. Celina, O.

11:30 Thyroid Diseases
Curran Pope, M. D. Louisville

Luncheon

Round Table Talks

Informal Discussions

AFTERNOON

2:00 Physical Therapy in Dermatology
Lynne B. Greene, M. D. Kansas City

2:50 Hypertension
Burton G. Grover, M. D., Colorado Springs

3:45 Practical Application of Physical Agents
Joseph E. G. Waddington, M. D., Detroit

4:40 Eye, Ear, Nose and Throat Diseases
M. H. Cottle, M. D. Chicago

EVENING, 7:30

The Rational Teaching of Physical Therapy
(a) Medical Students (b) Technicians
Harry Leslie Langnecker, M. D., Palo Alto, Cal.
Stanford University
Discussion opened by Prof. H. A. McGuigan, Chicago
University of Illinois College of Medicine
Harry E. Mock, M. D. Chicago
Northwestern University Medical School

Artificial Light in Tuberculosis (Illustrated)
Edgar Mayer, M. D. Saranac Lake
Discussion opened by Ellis B. Frelich, M. D., Chicago
Attending Physician (T. B.) Cook Co. Hospital

Physical Agents in the Treatment of Injuries
Harry E. Mock, M. D. Chicago
Northwestern University Medical School
Discussion opened by Frank H. Walke, M. D., Shreveport, and John Stanley Coulter, M. D., Chicago.

Physiologic Action of Light
C. I. Reed, M. D. Dallas, Tex.
Baylor University College of Medicine
Discussion opened by Prof. Arno B. Luckhardt
University of Chicago

C. I. Reed, M. D.

Wednesday, October 20, 1926.

MORNING

8:00 Registration to the Clinical Congress
8:30 Assembly—Executive Session of College
9:30 Formal Opening of Scientific Session—Joint Meeting.

Presidential Address—The Future of Physical Therapy
John Stanley Coulter, M. D., Chicago

10:30 Sectional Meetings
Section on Medicine, Diagnosis, Pediatrics, and Endocrinology

Ultraviolet Light in the Management of the Neuropathic Child
I. L. Sherry, M. D. .... Chicago
University of Illinois College of Medicine
Discussion opened by Joseph K. Calvin, M. D., Chicago

Multiple Furunculosis in Infancy with Special Reference to Ultraviolet Therapy
M. L. Blatt, M. D. .... Chicago
University of Illinois College of Medicine
Discussion opened by Francis Senear, M. D., Chicago

The Treatment of Neural Syphilis
Curran Pope, M. D. .... Louisville
Discussion opened by Meyer Solomon, M. D., Chicago

Indications for the Use of Sine Currents
Frederick G. Morse, M. D. .... Boston
Discussion opened by Roy W. Fouts, M. D., Omaha, and Joseph E. G. Waddington, M. D., Detroit

AFTERNOON, 2 O'CLOCK

Demonstration of Diathermy Technic
D. Frank Knotts, M. D. .... Chicago

Arthritis
W. Scott Keyting, M. D., Salt Lake City

X-Ray and Light Therapy in Tuberculosis
R. T. Pettit, M. D. .... Ottawa, Ill.

Diathermic Treatment of Nervous Diseases
Prof. Franz Nagelschmidt, Dr. Med., Berlin

Thursday, October 21, 1926.

MORNING, 9 O'CLOCK

Treatment of Pulmonary Tuberculosis
W. B. Chapman, M. D. .... Carthage, Mo.
Discussion opened by James A. Britton, M. D., Chicago.

The Present Status of Treatment in Arthritis
W. A. Johnston, M. D. .... Dubuque, Ia.

Diathermy and Internal Secretions
Prof. Franz Nagelschmidt, Dr. Med., Berlin

Autocondensation Therapy
Burton B. Grover, M. D., Colorado Springs

AFTERNOON, 2 O'CLOCK

Diathermy and Other Measures in the Treatment of Colle's Fracture
F. H. Ewerhardt, M. D. .... St. Louis
Washington University Medical School
Discussion opened by B. H. Sherman, M. D., Dexter, Iowa

Treatment of Intestinal Stasis
CLARENCE M. WESTERMAN, M. D., St. Louis.

Value of Physical Agents in Certain Skin Diseases
ERWIN P. ZEISLER, M. D. .... Chicago
Discussion opened by LYNNE B. GREENE, M. D. Kansas City.

History of Ultraviolet Ray Therapy
M. B. CIRLIN, M. D. .... Chicago

Section on Surgery, Gynecology and Urology

Wednesday, October 20, 1926

MORNNG, 10:30 O'CLOCK

Ultraviolet Radiation in Leg Ulcers
ARTHUR E. SCHILLER, M. D. .... Detroit
Discussion opened by LYNNE B. GREENE, Kansas City

Galvanism in Cervical and Endocervical Suppurations
J. U. GIESEY, M. D. .... Salt Lake City

Osteomyelitis
EMILE C. DUVAL, M. D. .... Chicago
Discussion opened by PAUL B. MAGNUSON, M. D., and R. W. MCNEALY, M. D., Chicago

Use of Physical Energies in the Management of Tuberculosis Peritonitis
A. DAVID WILLMOTH, M. D. .... Louisville
Discussion opened by GUSTAVUS BLECH, M. D., Chicago

AFTERNOON, 2 O'CLOCK

Galvanism in Sinuses and Fistulae
MILES J. BREUER, M. D. ..... Lincoln, Neb.

Experimental Observations on Infections of the Seminal Ducts (Illustrated)
HARRY C. ROLNICK, M. D. .... Chicago
Northwestern University Medical School
Discussion opened by DAMON A. BROWN, M. D., Madison

Bladder Tumors
BUDD C. CORBUS, M. D. .... Chicago
Discussion opened by HARRY C. ROLNICK, M. D.
President Chicago Urological Society

Radio-Frequency in Surgery
NELSON H. LOWRY, M. D. .... Chicago
Discussion opened by KARL MEYER, M. D., Chicago

Thursday, October 21, 1926

MORNING, 9 O'CLOCK

Traumatic Injuries
FRANK H. WALKE, M. D. ..... Shreveport
President, American Railway Surgeons Ass'n.
Discussion opened by CLARENCE M. WESTERMAN, M. D., St. Louis

The Role of Local and Regional Anesthesia in Surgical Diathermy
ARTHUR E. JONES, M. D. .... Chicago
Discussion opened by W. SCOTT KEYTING, M. D., Salt Lake City.

Diathermy in Diseases of the Male Urethra
DAMON A. BROWN, M. D. .... Madison
Discussion opened by V. J. O'CONNOR, M. D., Chicago.

Radium in Gynecology
HENRY SCHMITZ, M. D. .... Chicago
Loyola University School of Medicine
Discussion opened by C. W. HANFORD, M. D., Chicago

AFTERNOON, 2 O'CLOCK

The Importance of the Roentgen Ray Examination of the Kidney in Case of Pain in the Upper Right Abdominal Quadrant
BERNARD NICHOLS, M. D. .... Cleveland
Cleveland Clinic
Discussion opned by CARL BECK, M. D., Chicago.

The Status of Physical Therapy in Connection with Orthopedic Surgery
PHILIP H. KREUSCHER, M. D.
Discussion opened by PHILIP LEWIN, M. D., Chicago.

X-Ray Treatment of Enlarged Prostate
A. L. YOCOM, M. D. .... Chariton, Ia.
Discussion opened by A. E. JONES, M. D., Chcago

Bernard Nichols, M. D.

Actinotherapy in Infections

Wm. E. Howell, M. D. .... Chicago

Section on Eye, Ear, Nose, Throat and Oral Surgery

Wednesday, October 20, 1926

MORNING, 10:30 O'CLOCK

X-Ray Shadow Values—Their Standardization in the Dental Areas (Illustrated)

Wm. A. Lurie, M. D. .... New Orleans

Discussion opened by F. W. Lake, D. D. S., Boston

Ultraviolet Radiations in Oral Lesions

F. W. Lake, D. D. S. .... Boston

Tufts College Dental School

Ultraviolet Light in the Treatment of Pyorrhea and in Abscessed Teeth

I. L. Folstein, D. D. S. .... New York

Discussion of the two foregoing papers to be opened by Frederick Molt, D. D. S., Chicago

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Newer Aspects of the Problem of Partial Deafness with Special Reference to Physical Methods of Treatment

A. R. Hollender, M. D., and M. H. Cottle, M. D. .... Chicago

Discussion opened by Ellis G. Linn, M. D., Des Moines

F. W. Lake, D. D. S.

AFTERNOON, 2 O'CLOCK

Lymphoid Hyperplasias—Their Treatment with X-Rays and Ultraviolet Light

Ira O. Denman, M. D. .... Toledo

Discussion opened by J. R. Ranson, M. D., Denver

Radium in the Treatment of the Mouth, Pharynx and Larynx

Samuel Salinger, M. D. .... Chicago

Attending Otolaryngologist, Cook Co. Hospital

Discussion opened by C. W. Hanford, M. D., Chicago, and A. F. Tyler, M. D., Omaha.

Tumors of the Pharynx and Larynx

Frank J. Novak, Jr., M. D. .... Chicago

Technic in Applying Ultraviolet to Oral and Nasal Cavities

Jos. Gale, M. D. .... Chicago

Thursday, October 21, 1926

MORNING, 9 O'CLOCK

Diathermy and Surging Sinusoidal Currents in Impaired Sound Conduction

Ellis G. Linn, M. D. .... Des Moines

Discussion opened by A. R. Hollender, M. D., Chicago.

Interpretation of Radiograms in Nasal Accessory Sinus Disease

A. F. Tyler, M. D. .... Omaha

Discussion opened by J. R. Ranson, M. D., Denver; S. A. Levey, M. D., St. Louis

Nasal Accessory Sinus Disease

A. R. Hollender, M. D. .... Chicago

Discussion opened by Wm. A. Lurie, M. D., New Orleans

Tonsil Desiccation

William L. Clark, M. D. ..... Philadelphia

Wm. L. Clark, M. D.

AFTERNOON, 2 O'CLOCK

Treatment of Nerve Palsies

J. C. Elsom, M. D. .... Madison

University of Wisconsin

Discussion opened by Frank J. Novak, Jr., Chicago

EVENING PROGRAMS

Wednesday, October 20, 1926

8:00 O'CLOCK

Dinner in Honor of our Invited Guests

Physical Therapy in Relation to the State Medical Society

G. Henry Mundt, M. D. .... Chicago

President-Elect Illinois State Medical Society

Present Day Aspects of Physical Therapy

Harry E. Mock, M. D.

Chairman of Council on Physical Therapy, American Medical Association

Discussion to be opened by Prof. Arno B. Luckhardt, *University of Chicago*. Prof. A. C. Ivy, *Northwestern University Medical School.*

Physical Therapeutics, Its Development During the Past Decade

Geo. B. Lake, M. D. .... Chicago

Editor, "Clinical Medicine"

Thursday, October 21, 1926

7:30 O'CLOCK

Electrothermic Methods in Surgery

William L. Clark, M. D. Philadelphia

Discussion opened by Gustav Kolischer, M. D., and Frank J. Novak, Jr., M. D., Chicago.

Combined Physiotherapy in the Treatment of Obesity

Franz Nagelschmidt, Dr. Med., Berlin, Germany

Discussion opened by Chas. Phillips Emerson, *Dean University of Indiana Medical School* and Chas. E. Stewart, M. D., Battle Creek.

Informal Smoker-Entertainment

Buffet Luncheon

Friday, October 22, 1926.

MORNING, 9 O'CLOCK

Joint Meeting of All Sections

High Frequency Currents in General Practice

D. Frank Knotts, M. D. .... Chicago

Hydrotherapy in Chronic Disorders

Chas. E. Stewart, M. D., Battle Creek, Mich.

Discussion opened by Curran Pope, M. D., Louisville

Ultraviolet Light in Relation to the Calcium Factor in Normal and Pathologic States

EDWIN N. KIME, M. D. .... Indianapolis

University of Indiana Medical School

Discussion opened by MAXIMILLIAN KERN, M. D., Chicago

Roentgenographic Studies of Pituitary Types (Illustrated)

MAXIMILLIAN KERN, M. D. ...... Chicago

Discussion opened by CURRAN POPE, M. D., Louisville

Diathermy from the Surgeon's Standpoint

E. C. HENRY, M. D. .... Omaha

AFERNOON, 2 O'CLOCK

The Role of Surgical Diathermy in Cancer Therapy

GUSTAV KOLISCHER, M. D. .... Chicago

Discussion opened by D. KOBAK, M. D., Chicago, and A. L. YOCOM, M. D., Chariton, Ia.

The Value of Dye in X-Ray Examination of the Gallbladder

ROY W. FOUTS, M. D. .... Omaha

The Value of Lipiodol in X-Ray Examination of the Lungs

ALBERT F. TYLER, M. D., Omaha

Discussion of the two foregoing papers opened by ADOLPH HARTUNG, M. D., Chicago.

Ionization

G. BETTON MASSEY, M. D. ... Philadelphia

Discussion opened by J. U. GIESEY, M. D., Salt Lake City

SATURDAY CLINICS*

9:00 American Hospital (Ampitheatre, 4th floor)

Hay Fever and Asthma

A. R. HOLLENDER, M. D.

Partial Deafness M. H. COTTLE, M. D.

10:30 Cook County Hospital

General Physical Therapy

JOHN STANLEY COULTER, M. D., and D. KOBAK, M. D.

2:00 Wesley Hospital (Amphitheatre, 3d floor)

Industrial Physical Therapy

PAUL MAGNUSON, M. D.

3:00 Cook County Hospital

Surgical Diathermy

D. KOBAK, M. D., and JOHN STANLEY COULTER, M. D.

*Several of our prominent guests will take active part in these clinics. Other clinics are being arranged.

ENTERTAINMENT FOR THE LADIES

A complete program of entertainment is being arranged for the lady guests who attend the meeting. The doctors are urged to bring their wives.

ENTERTAINMENT FOR THE SMOKER, DINNER, ETC., WILL BE FURNISHED BY THE ORPHEUM CIRCUIT.

EXHIBITORS

VICTOR X-RAY CORPORATION

H. G. FISCHER & COMPANY

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BATTLE CREEK FOOD CO.

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HIGH TENSION COMPANY

McINTOSH ELECTRICAL CORPORATION

WAPPLER ELECTRIC COMPANY

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SPECIAL RAILROAD RATES

Special railroad rates of one and one-half fares on the certificate plan have been granted for the Clinical Congress and American College of Physical Therapy by the following passenger associations:

Trans-Continental Passenger Association
Western Passenger Association
Central Passenger Association
Southwestern Passenger Association
Southeastern Passenger Association
New England Passenger Association
Canadian Passenger Association
Trunk Line Association

Get a certificate and bring it with you to the meeting or you cannot participate in these rates.

THE INSTRUCTION CLASSES

A unique feature of this year's program is the section on instruction. It is an initial attempt to give to physicians and their technicians a systematic course in the theoretical and practical sides of therapeutics. The names of the instructors who are to take part are well known in the medical profession. They are men who have had a thorough experience in the specialty. They are clinicians—all of them, busy doctors who have come to regard the use of physical agents as an important and valuable help in treating the sick.

Those who are seeking an intensive post graduate course in physical therapy should register their names early with the chairman of the program committee. Physicians are invited to encourage the enrollment of their assistants and technicians. These classes are open to them because we wish to broaden their knowledge and perfect their technique—all of which will make for better results in our daily practice. A further reason for permitting properly vouched for technicians to take this instruction work is the fact that there are but few suitable courses available at the present time. And until such time that the medical schools see fit to offer post graduate instruction in physical therapy, the College feels justified in continuing along these lines.

While the clinical congress program of addresses, clinics and round table talks is not included in the instruction work proper, it is quite evident that these features will help materially to round off a solid week of physical therapy.

It is gratifying to note the large list of names already registered—doctors from Maine to California are looking forward to this congress. We shall see to it that they are not disappointed.

Our advice is—if you have not already done so—to register at once with the chairman of the program committee, Dr. A. R. Hollender, 30 N. Michigan Ave., Chicago.

ANNUAL MEETING

The program of the annual meeting appearing in this issue casts great credit upon the program committee and should appeal to every man interested in physical thrapy. The wide diversification of the subjects presented makes this program unique in many respects; clinicians, physicists, university teachers are all offering their share to the material in hand.

The first two days will be devoted to instruction classes, the next three days

to papers of members and invited guests, while the last day will be occupied by clinics at the various Chicago Hospitals.

We sincerely believe that the man interested in physical therapy cannot afford to be absent from this meeting. Special railroad rates have been granted on the certificate plan. These rates are only effective provided 250 or more certificates are properly validated at the meeting. When you purchase your ticket be sure to ask for a certificate and bring it with you to the meeting.

Get a railroad certificate! A.F.T.

FRANZ NAGELSCHMIDT

The American College of Physical Therapy is indeed fortunate in being honored by the presence of Franz Nagelschmidt of Berlin at the annual meeting. He will appear on the program twice, Monday evening and again Thursday evening.

It will be recalled that in 1908 Franz Nagelschmidt called attention to the value of the high frequency current in the treatment of disease as employed in his own practice. In 1910 he gave a demonstration of the surgical application of this current at St. Bartholomew's Hospital, London, where he operated upon three cases, the first ones to be so treated in England. Here then is an opportunity to hear a pioneer in the use of diathermy speak twice and to meet him and mingle with him socially.

A.F.T.

SYMPOSIUM

It is with pleasure that we call attention to the symposium on actinotherapy beginning in this issue. The first article of this series is by Professor W. T. Bovie, Assistant Professor of Biophysics, Harvard University, who is also a member of the Council on Physical Therapy of the American Medical Association. Others who will contribute to this symposium are Dr. Rollier of Leysin, Switzerland, the pioneer and leader in heliotherapy; Dr. Edgar Mayer of Saranac Lake; Dr. LoGrasso of Perrysburg, N. Y., and Dr. Pottenger of Monrovia, California.

Beside this symposium all other phases of physical therapy will be presented so that none interested can afford to be without the *Achives of Physical Therapy, X Ray, Radium.* A.F.T.

PHYSIOTHERAPY AIDE PHYSIOTHERAPY ASSISTANT

Applications for these positions must be on file at Washington, D. C., not later than October 9 or November 27. The dates for assembling of competitors will be stated on the admission cards sent applicants after the close of receipt of applications. Applications received after a closing date will be considered for the next date.

The examinations are to fill vacancies in the field service of the Public Health Service and the Veterans' Bureau, and a vacancy in St. Elizabeth's Hospital, Washington, D. C.

The entrance salary for physiotherapy aide ranges from $1,020 a year with quarters, subsistence, and laundry to $2,040 a year without allowances, and the entrance salaries for physiotherapy assistant range from $1,320 to $1,680 a year. Promotion may be made in accordance with the civil service rules as vacancies occur.

The duties of physiotherapy aides consist of administering physiotherapy in its several branches, such as massage, electrotherapy, hydrotherapy, mechanotherapy, thermotherapy; active, passive, resistive, and assistive exercises and remedial gymnastics; keeping daily record of the work and progress of each patient coming under direction and treatment; and making the required reports of the activities of the reconstruction work in physiotherapy.

The duties of physiotherapy assistants consist of administering to special cases the treatments of physiotherapy as shown above, and other work similar to that of physiotherapy aides.

CASE REPORTS

MALIGNANT MEDIASTINAL TUMOR
Complicated by Amoebic Infection

Ernst A. Schmidt, M. D.
X Ray Department, Colorado General Hospital, University of Colorado, School of Medicine
Denver, Colorado.

THE apparent rarity of tumors of the thymus, so-called thymomata, as well as the special complications of the following case appear to justify the publication of a brief report.

The patient, a woman, white, 55 years of age, was admitted to the hospital November 29, 1925.

Complaint: She complained of cough, "heaviness" over chest, loss of weight, weakness, diplopia, occasional vomiting and tenderness of hands and feet.

Family History: The family history was essentially negative.

Personal History: Besides the usual childhood diseases, malaria (?) at the age of 11, pneumonia at 13, "night sweats due to goitre" at 17, influenza the year before, jaundice six and ten months previously, "chronic cough and some pleurisy" in recent years, were all given.

Physical Examination: The physical examination revealed considerable emaciation and muscular atrophy (combined with marked tenderness) of upper and lower extremities; dullness over lower half of right thorax and increase of vocal fremitus over right apex. On either side the supraclavicular glands were palpable and tender, and there was an apparent enlargement of liver and spleen.

Laboratory Examination: The urinalysis showed amoebae; albumen at first negative, later positive.

Blood Findings: Erythrocytes 4,600,000; leukocytes 22,200; hemoglobin 79; differential count, polymorpho-nuclears 86 per cent; small lymphocytes 18 per cent; endothelials 2 per cent. Wassermann reaction, negative.

Sputum and Pleural Fluid Examination: Numerous amoebae (probably Entamoeba histolytica); no tubercle bacilli.

Temperature between 99 and 103; pulse 120; respiration 24.

X Ray Examination: The x ray examination showed the condition seen in Fig. 2:

1. Lower third of right lung is obscured by almost homogeneous density,

*Received for publication April 19, 1926.

partly due to pleural effusion (as evidenced by shifting of fluid level on change of position), partly due to circumscribed shadow at the base of right lung.

2. Smaller densities in the left hilum region, suggests metastatic invasion of the left side.

3. Marked fibrotic changes involve the whole bronchial system.

The x ray examination of the esophagus revealed a constriction, conical in shape with the apex pointing downward and persisting after atropin, at the level of the sixth dorsal vertebra (Fig. 4). The examination of the gastro-intestinal and urogenital tracts proved negative except for marked hyperperistalsis of the colon and moderate hydronephrosis of the right kidney.

Both hands showed very extensive periosteal changes of the lace work type in metacarpals and phalanges, less marked in carpals (Fig. 3). The same changes involved the lower halves of both tibiae and fibulae and the distal portions of radii and ulnae. The joints were apparently free from pathological change.

Progress and Treatment: A roentgenogram taken six weeks prior to patient's admission and kindly supplied by Drs. Holden and Hazelton of the Agnes Memorial Sanatorium, Denver, proved extremely valuable in the interpretation of the disease (Fig. 1). While the advanced pleural pathology at the time of our first x ray examination did not allow a definite differentiation between mediastinal tumor and sequelae induced by a suspected perforation of the diaphragm

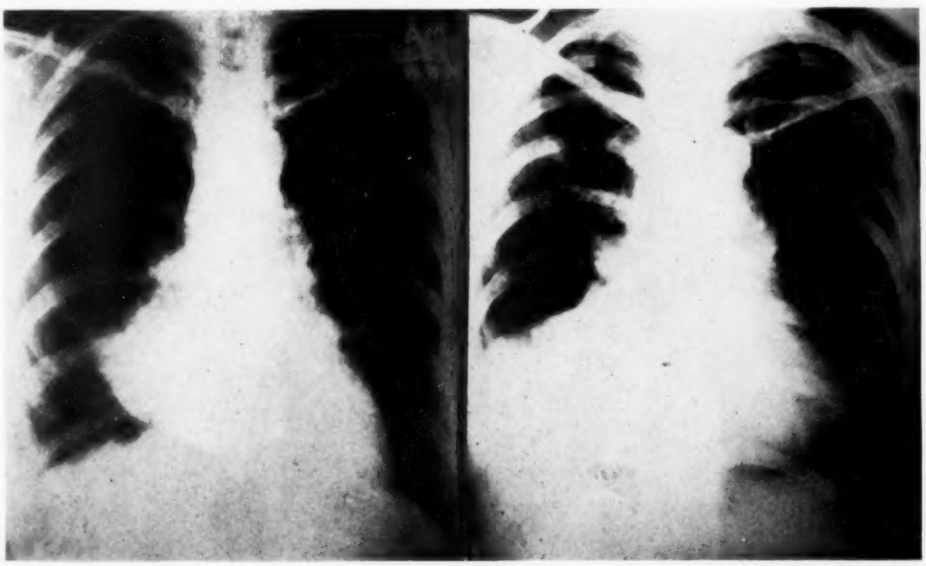


Fig. 1.—A roentgenogram taken six weeks prior to patient's admission, demonstrating the extension of the tumor from the base of the right lung —excluding the hepato-diaphragmatic origin.

Fig. 2.—X ray taken at time of admission showing a homogeneous density in lower third of right lung, metastatic invasion of left side and fibrotic changes.

following an amoebic liver abscess (which appeared rather probable on account of the history of icterus, the rise of temperature, liver enlargement, findings of amoebae in sputum and pleural fluid, etc.), this earlier picture excluded the hepato-diaphragmatic origin of the thoracic involvement by clearly demonstrating the extension of the tumor from the base of the right lung.

Treatment with deep x ray therapy was started, but had to be discontinued, as patient left the hospital January 17, 1926. Death occurred within one month after discharge from the hospital. The autopsy (which will be reported in detail later by Dr. Mills of the Department of Pathology of the University of Colorado, School of Medicine), showed a large tumor of the thymus with metastases in the regional lymph glands. No liver abscess was found. The constriction of the esophagus was due to pressure by the enveloping tumor.

The rather low position of the thymoma in the roentgenograms appears to be atypical; according to Wessler, Jaches, Ewing and others, thymomata usually arise from the superior mediastinum. The relatively short time between the first symptoms of the disease and the death of the patient demonstrates the malignancy of the affection. As for the reported bone changes, we are rather inclined to attribute them to amoebic infection than to simple pulmonary osteoarthropathy, although we have found no basis for this conclusion in the literature. No data were obtainable as to the onset of the amoebiasis, nor were there any indications to suggest an etiologic relationship between the amoebic infection and the mediastinal malignancy.

4200 East Ninth Avenue.

Fig. 3.—Periosteal changes of the lace work character involving metacarpals and phalanges, existing but slightly in carpals.

Fig. 4.—Esophageal constriction continuing after atropin.

DEPARTMENT *of* TECHNIQUE

INTERCHANGEABLE LUNG LANDMARKINGS*

Wm. J. Manning, M. D.
Washington, D. C.

The illustration shown depicts a method utilized by the author in attempting the interpretation of lung films and plates which may prove of passing interest to roentgenologists who with others are not always sure as to points of orientation. Without definite guides or landmarks of a specific nature concerning radiopaque, radioparent, and radiolucent shadows, it is very difficult at times to differentiate those shadows ramifying toward the bronchio-mediastinal lymph and intercostal nodes from those arising from the pulmonary substance or parenchyma and terminal bronchioles.

The first or eparterial branch of the right bronchus which is placed above the pulmonary artery and the second or hyparterial branches which are placed below the pulmonary artery converging to the middle lobe are well shown and stand out prominently. The ventral or large, and the small or dorsal branches distributed to the lower right lobe are also well defined together with the entire arborization.

*Received for publication July 1, 1926.

The hyparterial branches of the left bronchus being all below the pulmonary artery are seen to be distributed, respectively, to the upper and lower lobes of the left lung. The lines of demarcation, in an arboreal arrangement, differentiates the oblique fissure. A similar condition or division of the right lung between the horizontal and oblique fissures can also be clearly discerned.

The depicted markings will be found useful, upon trial, in the third and other stages of tuberculosis in locating a disseminated cavity formation as well as necrotic areas as to size and point of fixation on specific lobes, and other pathological conditions inclusive of foreign bodies. In the second stage of tuberculosis with the characteristic "mottling" effect and where more area is involved than the apex, the markings will be found helpful in the report description. Even in the first stage with the development of the Dunham fans at the periphery and the exudative infiltration arising from the foci in the apex due to the toxins being collected and drained into the lymphatics and manifested in the terminal air cells

the lungs where the dividing aborization extends much farther into and toward the dorsal and ventral termini at chest walls.

Lung landmarking by the use of bismuth or barium and other radiopaque substances being blown into the respective bronchus by Dr. Chevalier Jackson and his distinguished associates of Philadelphia has been readily utilized to outline the bronchi when such prepared areas in the living subject were exposed to the roentgen ray. To those roentgenologists lacking the necessary technique and experience of these gentlemen the features of this method outlined may appear helpful.

In the application of the landmarks shown to any lung picture that is made on a 14 by 17 film or plate, the printed negative is placed either behind or superimposed on the film or plate to be examined and viewed by a strong light from the rear. A picture resembling that shown on Fig. 1 will be observed for study due to the transmitted light through each film or plate. The marked negative or guide should be printed upon a semitransparent material such as a gelatin film or onion skin paper permitting the transfused light to pass through. In my own cases a glass negative is utilized, being held against the examined film or plate by means of spring clothes pins.

The normal division of the bronchi in the human will be found at the sixth thoracic vertebra and if the observer will place his marked guide over this point in the film to be examined and secure both firmly and closely in place he will have an accuracy sufficient for all working purposes with a minimum of error and a maximum in return for his trouble or work.

The original copy of picture shown in Fig. 1 was obtained in the Army Medical Museum, this City, being prepared by injecting the lungs with a thin mixture of glycerin and barium, utilizing the gravity method employed in dissecting rooms when cadavers are prepared for dissection. The age of the subject was 33, body was normal and free from disease, traumatism being cause of death. The prepared part was exposed to roentgen ray and the negative photographed.

Suite 707, Medical Science Building.

as small radiolucent areas when accompanied by epithelial cells, debris, etc., sufficient in amount to cast a shadow, the orientation of such shadows is helped materially.

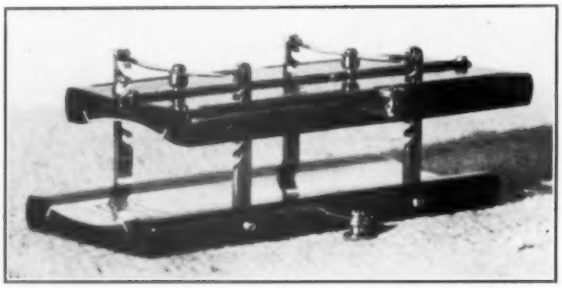
Note should be taken of the absence of the small divisions of the bronchi in the apical regions; the existing substance or parenchyma form a most suitable ground as a focus, once the infection takes place, due to the choke or absence of air channels or bronchi of any significance. This condition mentioned is much more marked than at the peripheral walls of

Fig. 1.—Showing the injected normal lungs with a mixture of glycerin and barium, accomplished by the gravity injection method.

NEW EQUIPMENT

DIATHERMY ELECTRODE

ADOPTED FOR MALE URETHRAL INFECTIONS



The patent was granted June 8th, 1926, to Dr. T. T. Gibson of Middlesboro, Ky., on an electrode made for the purpose of treating infections located in the male uretha. After experimenting for a number of years, Dr. Gibson devised this electrode and has found it very efficient in his year's application.

The body of the electrode is composed of two hard rubber bodies, each lined on the concave side with metal, so arranged that the metals cannot come in contact with each other. Each lining has a metal conductor extending to the outside of each body, with binding posts for attachment to the machine. A unique device is arranged to hold the electrode in place while the treatment is being given. Two resilient bars are constructed so as to automatically allow for displacement in case of an expansion of the penis occurring after the electrode is in place and the current turned on. Attached to a diathermy machine this electrode radiates heat for the purpose of elevating the temperature of the urethra to such a degree as to be tolerated by the patient yet bactericidal. By placing wet pads on the medals, it is very convenient to use galvanism through the urethra. Anterior gonorrheal urethritis responds well to this therapy.

In chronic cases of gonorrhoea whree the infection has involved the posterior urethra, a piece of block tin, 10 by 10, is placed well down on the back beneath the buttock, a piece 6 by 9, is moulded around the penis and testicles and held in place with a sandbag or

bandage. This method has been used to generate heat in the posterior urethra.

In connection with the diathermy treatment, Dr. Gibson always requires the patient to wear a gonorrhoeal bag, containing gauze that may be changed when soiled, to prevent the discharge from soiling the clothing and reinfecting the sterile field.

The medication that accompanied this method of therapy has been copious draughts of water, and an alkalinization of the urine, his favorite combination being Salol, Tr. Belladonna, Sat. Sol Magnesium Sulphate, Potassium Acetate, and Elixir Buchu Juniper.

The average length of treatment reported by Dr. Gibson has been from five to ten days—daily treatments, of from once, twice to thrice or more applications daily of forty-five to sixty minutes each, according to the severity of the infection.

This preliminary report precedes the adoption of this instrument by commercial agents, the electrode only being obtainable at this time direct from its constructor, Dr. T. T. Gibson, of 1904 Cumb Ave., Middlesboro, Kentucky.

THE STUDENT'S LIBRARY

BOOKS RECEIVED

This column is devoted to acknowledgment of the books received. Such acknowledgment must be regarded by the sender as sufficient recognition of the courtesy until time and space permit selections to be made for review.

ESSENTIAL FACTS ABOUT CANCER. A handbook for the medical profession. American Society for the Control of Cancer, 25 West 43rd St., New York.

ELECTROTHERMIC METHODS IN NEOPLASTIC DISEASES. Designed as a practical handbook of surgical electrotherapy for the use of practitioners and students. By *J. Douglas Morgan,* B. A., M. D.; formerly radiologist, Ross Pavilion, Royal Victoria Hospital, Montreal; instructor in radiology, Univ. Pennsylvania Graduate School of Medicine, etc. Cloth. Price $2.50. Pp 172 with 36 line and half-tone engravings. Philadelphia: F. A. Davis, 1926.

ERGEBNISSE DER MEDIZINISCHEN STRAHLENFORSCHUNG. Roentgen diagnosis, roentgen, radium, and light therapy. Vol. II. Compiled by *H. Holfelder,* Frankfort; *H. Holthusen,* Hamburg; *O. Jungling,* Tubingen; *H. Martius,* Bonn a.Rh. Paper. Pp. 594 with 520 illustrations and three photographic tables. Leipzig: George Thieme, 1926.

THE GENUINE WORKS OF HIPPOCRATES. Translated from the Greek with a preliminary discourse and annotations, by *Francis Adams,* LL. D., Surgeon. Two volumes in one. New York: William Wood & Company, n. d. Price $6.00.

The medical profession as a whole knows little of the detail of the work of the early laborers in the field of medicine. The appearance of a work of this type which gives an accurate translation in English of the writings of the "Father of Medicine" is a distinct addition to medical literature. Adams selects those works of Hippocrates which he believes were written by the great teacher himself and gives his reasons for their selection. He includes some others which he considers somewhat doubtful. He is very fair in stating the ideas of other great medical historians and when he differs with them gives plainly the reasons for the disagreement. He gives also a general historical review of the time of Hippocrates and an account of his life.

The body of the work consists of translations of the works of Hippocrates. First those which are admitted by all historians to be genuine; then those which the author considers to be genuine but in this opinion differs from some historians; finally he gives the doubtfully genuine works which are important. Each individual work is preceded by an "argument" which explains the translation that follows and places it in its proper position historically, giving when possible the general concensus of opinion as to why Hippocrates wrote the particular work. The argument also calls attention to the similarities and differences between the diagnosis and treatment in the days of Hippocrates and the ideas prevailing at the time this book was written. As Mr. Francis Adams, the author, a surgeon of Banchory, Scotland, died in 1861, before the advent of the era of asepsis, the use of the x ray in fractures and the many other advances of the last decades of the nineteenth and the first quarter of the twentieth centuries, the book has a special appeal to the reader interested in medical history as it thus covers a double period and gives, at first hand, the opinions and a summary of the medical knowledge of two of the most interesting epochs in history; that of the beginning of medicine, and that of the period just preceding the era of modern surgical advance.

The book throws little new light on the work of Hippocrates, but it does make available in well written English the works of this great clinical observer. Any physician who will read it carefully will obtain a great insight into the medicine of the olden days and the careful clinical methods of that time and should also gain from it a spirit of humility for himself and a sense of respect for the knowledge of the "Father of Medicine."

The work of the publisher is artistic. Its beautiful binding and unique composition make it an elegant addition to any book lover's domain.

ALFRED BROWN, M. D.

INTERNATIONAL CLINICS. Vol I. Thirty-sixth series. A quarterly of illustrated lectures. Edited by *Henry W. Cattell,* A. M., M. D., with collaboration of international authorities. Cloth. Pp. 309 with 89 plates, charts and figures. Philadelphia: J. B. Lippincott & Co., 1926.

In organizing this series of 20 manuscripts, five general subdivisions were made:

I. Under Diagnosis and Treatment, the *sequelae of diphtheria* are discussed by H. B. Cushing. The diagnosis and treatment of *cardiac arhythmias* are given special consideration by Edward C. Reifenstein, while G. Paul Laroque enumerates salient facts to be constantly remembered in the treatment of abdominal conditions, conspicuously *appendicitis.* The trend of thought then turns toward the laboratory. L. M. Jourda of Toulouse, France, discusses *blood dilution in the pathology and treatment of attacks of gout.* The *development of psychiatrical research* is presented by Professor E. Kraepelin of Munich, followed by Professor F. Plaut's description of the *treatment of metasyphilitic disorders of the nervous system with infectious diseases,* relapsing fever in particular. The section closes with A. P. C. Ashhurst's presentation of *the motions of the larger joints.*

II. Electrotherapeutics and physiotherapy receive special consideration. In the opening monograph, Frederick DeKraft emphasizes the

clinical action of diathermy. William B. Snow adequately reviews *the treatment of local infection.* The question of *radiotherapy of the blood and lymph tissues* is admirably summarized by no less an authority than Joseph Muir. The *contra-indications to the use of radium in gynecology* occupies the attention of C. Jeff Miller.

III. The section on Medicine opens by a consideration of *paraplegia in Hodgkin's disease and leukemia,* and raises the question of there being a Hodgkin Sarcoma as well as a Hodgkin Granuloma, by F. P. Weber. Norman B. Gwyn discusses *massive collapse of the lungs,* while E. H. Mason of Montreal, presents a *life history of a case of nephrosis.*

IV. A very interesting opener in Surgery is W. A. Hendricks' monologue on *a day in Dr. Charles H. Mayo's clinic.* The *diagnosis and treatment of acute superficial circumscribed abscess* by E. Horgan follows. The time old question of the *surgical treatment of gastric and duodenal ulcers* is modernized by C. F. Nassau. Interesting *surgical clinics from the Broad Street Hospital of New York* are presented by W. M. Brickner and H. Milch.

V. In discussing the Progress of Medicine for 1925, H. W. Cattell and Major J. F. Coupal present a *collation* of the last year's advances, while D. C. Balfour and J. S. Reid emphasize the *recent progress in surgery.*

A quarterly summarizzation of the medical advances compounded by the best of medical authorities enables the busy practitioner, whether generalized or specialized, to maintain a constant contact with the entire field. Such a knowledge is essential for the modern man.

THE NEWER KNOWLEDGE OF NUTRITION. Third edition. By *E. V. McCollum,* Ph. D., Sc. D., Professor of Chemical Hygiene, Johns Hopkins University; and *Nina Simmonds,* Sc. D., Associate in Chemical Hygiene, Johns Hopkins University. Cloth. Pp. 675 with 2 charts, 34 tables and 24 figures. New York: Macmillan Co., 1925.

The rapid progress made by the ever increasing band of investigators in the field of nutrition so antiquated the second edition written only three years ago as to necessitate a complete revision of the previous text. The present text, attempting to expand so as to depict accurately this recent progress, has preserved the facts and fascination developed by the former edition, and has interwoven the more recent research findings so as to present a modern comprehensive treatise on nutrition.

The historical method of presentation has been preserved, unveiling the science of nutrition as it evolved step by step by describing the significant researches in the order of their appearance. Repeated failures characterized experimental studies in which animals were confined to diets containing only the well-known food principles. Biological methods for the analysis of foodstuffs were then developed especially by Osborne, Mendel and McCollum. Simultaneously various ideas were propounded on nutrition, varying from the calorimetric value of foods through the dynamic action of foodstuffs, chemical analysis, digestive end products to physical requirements. At this stage the research efforts diverged along different channels. Those interested directly with the analysis of food content and their relation to nutrition developed our knowledge of the proteins—their nutritive value, structural contents and wide variations, their relation to the amino acids and finally the physiological requirements of man for protein—the dietary properties of individual foodstuffs, and the dietary deficiency diseases. From these studies, our knowledge of scurvy, beri-beri, polyneuritis, xerophthalmia, and pellagra developed. Later the relation of iodin deficiency to endemic goiter was demonstrated by Marine and Lenhart. The skeletal malformations and maldevelopment were related to the deficiency diseases, rickets playing the leading role. Steenbock and Hart working along practically the same trend of thought as Hess and McCollum demonstrated the relationship of green food, dry food and calcium assimilation to animal de-

velopment. These observations the authors refer to man. To crystalize these thoughts, the dietary habits of man are reviewed and the relationship developed between diets and resistance of man to disease. A complete bibliography is appended.

CLINICAL LABORATORY MEDICINE. By *Henry M. Feinblatt*, M. D., Director of Laboratories, United Israel-Zion Hospital, and Assistant Clinical Professor of Medicine, Long Island College Hospital; and *Arnold H. Eggerth*, A. B., A. M., Associate Professor of Bacteriology, Long Island College Hospital. Cloth. Price $5.00. Pp. 424 with two colored plates and 87 engravings. New York: William Wood & Co., 1925.

The object of this text is the presentation of laboratory medicine through clinical interpretation. Recognizing that the laboratory is not a mathematical workshop designed to give final judgment on any condition but simply a means to the end, the text becomes a clinical work—dealing with laboratory findings as you would consider the clinical data in the hospital routine.

In the words of Dr. Luther F. Warren, "to the beginning student of clinical medicine, it impresses him from the onset with the necessity of interpreting the findings of the laboratory through the problem at hand—applying the laboratory to his patient. . . . to the practitioner, it points out to him both the caution that must be used in interpreting the findings of the laboratory and the aid he may be expected to get from it in terms of prognosis."

Of the numerous laboratory procedures discussed, there are those that characterize this publication. A chapter so commonly admitted is devoted to the preparation of culture media. A short practical chapter of but four pages is used in the discussion of the cleaning and sterilization of glassware and simple glass-blowing. The determination of hydrogen concentration is a difficult subject which the authors present in a comprehensible manner. Other especially unique presentations are those on the examination of spinal fluid, stressing the sugar determination, a discussion of the basal metabolism test, and a chapter on blood cultures. The final chapter on the preparation, standardization and use of the autogenous vaccines is very good, the best that the reviewer has had the pleasure of reading.

With such an object so ably performed this text becomes one of the most valuable textbooks for students and a handy laboratory guide for the general practitioner.

INTESTINAL TUBERCULOSIS. By *Lawrason Brown*, M. D., Chairman of the Medical Board of the Trudeau Sanatorium, Saranac Lake, New York; and *Homer L. Sampson*, roentgenographer of the Trudeau Sanatorium. Cloth. Price $4.00. Pp. 304 with 112 illustrations. Philadelphia: Lea & Febiger, 1926.

This text is the first of a series of texts which propounds the results of the researches of a part of the staff of the Trudeau Sanatorium along one of its lines of thought—the fruition of one of the ideals of Dr. E. L. Trudeau. When the Adirondack Cottage Sanatorium was founded forty years ago, the major purpose of Dr. Trudeau was to cure the cases of beginning tuberculosis by enquiring into the nature of this mysterious disease, mastering its secrets and elaborating them to fellow practitioners. His aim was to put the control of the disease into men's hands, and to enable them to protect themselves from it.

By fulfilling Dr. Trudeau's ambition, by aiding the medical profession to combat one of mankind's bitterest and most ruthless foes, the writers have done a wonderful duty to their fellow men when they fulfill the precept of Hippocrates, the Father of Medicine, who asks "by precept, lecture and every mode of instruction impart a knowledge of the healing art."

One realizes the importance of the subject of intestinal tuberculosis when one knows that this is the most frequent complication of pulmonary tuberculosis, that in 1923 90,000 persons died from pulmonary tuberculosis in the registration area of the United States and of these 40,000

to 60,000 also had intestinal tuberculosis. The deplorable fact is that the present status of the diagnosis of intestinal tuberculosis is comparable to that of pulmonary tuberculosis twenty-five years ago when an early diagnosis aroused comment.

After emphasizing the importance of this condition, suggestive symptoms manifesting the probable beginning of intestinal tuberculosis are elaborated upon. "As the symptoms and abdominal examinations are so often negative and clinical diagnosis so uncertain, we must turn to the study of the barium meal by the roentgen rays to exclude intestinal tuberculosis. . . . No moderately or far-advanced case of pulmonary tuberculosis can be assumed to have been thoroughly examined unless a roentgen ray study of the bowel has been made. This is the only method which will diagnose intestinal tuberculosis in its incipiency or exclude it at any stage."

In the treatment of the condition, "medicinal treatment, when diarrhea is absent, is of little avail." Surgical interference has its place together with the ultra violet rays and natural heliotherapy. Roentgen therapy has its indications.

This monograph demonstrates the ideal of medicine. With the interest of the patient at heart, the authors offer the results of their efforts to fellow practitioners so that they may know and their patients may benefit. Fulfilling the ideals of this publication, we heartily commend this text and congratulate the authors. Anxiously do we await others of the series.

DISTURBANCES OF THE HEART. Third edition revised. By *Oliver T. Osborne*, A. M., M. D., Professor of Therapeutics, Emeritus and formerly Professor of Clinical Medicine in the Medical Department of Yale University. Paper. Pp. 294. Chicago: A. M. A. Press, 1925.

A knowledge of the anatomy and physiology of the heart can be acquired by reading and study. The ability to diagnose and treat cardiac conditions is an enviable superiority obtained only through careful scientific observation and practice. To be able to put this knowledge, thoughtfully evaluated, into words easily comprehensible for those of lesser experience and observations is an art. One of the greatest of internists presents here a compact, comprehensible monograph—a credit to modern medicine.

In this little text, the various forms of cardiac disturbances are considered together with the therapy indicated. Of prime importance in the treatment of diseases of the heart is a determination of the exact, or approximately exact condition of its structures and a determination of its ability to work. To obtain this knowledge, special laboratory determinations are usually called into play. These are presented by the writer in a simplified manner.

Special attention is given the question of blood pressure. "An abnormal condition cannot be properly treated, an operation should not be performed, and a prognosis is of little value without a proper consideration of the sufficiency of the circulation, and the condition of the circulation cannot be properly estimated without an accurate estimate of the systolic and diastolic blood pressure."

Each cardiac condition is next considered from the etiology, symptomatology, prognosis and treatment—the latter receiving the greatest consideration. Hypertension followed by hypotension precede the cardiac conditions: pericarditis, myocarditis and endocarditis. Chronic valvular diseases are given special discussion. Degenerations and cardiovascular renal diseases are also detailed.

An authoritative internist and a comprehensible writer, the author's little text should receive the corroboration of students and practitioners.

HIGH FREQUENCY PRACTICE. Fourth edition. By *Burton B. Grover, M. D.*, President Western Electrotherapeutic Association, Fellow American Electrotherapeutic Association, Fellow American College of Physical Therapy, etc. Cloth. Price $6.00. Pp. 555 with 71 figures. Kansas City: Electron Press, 1925.

After a preliminary review of the nature of electricity and magnetism, the author merges into the discussion of the physics of high frequency currents. This he presents in a simple yet comprehensible manner as possible, being interested in having it understood by students and general practitioners. This elementary discussion of physics he relates to the physiology of the human organism.

The application of these principles are first considered under medical diathermy. Here the physiology of the cell forms the working basis for his application, collaborated by a series of experiments on the preparation of electrodes and the methods employed to obtain the best physiological results. Surgical diathermy is discussed from both the advantages and disadvantages of desiccation. The works of Clark, Morgan, and Asnis form the nucleus around which the author weaves his conclusions.

Special consideration is given the subject of blood pressure. One would be disappointed in reviewing a work by the author that did not contain a liberal discussion of this important subject on which he has spent a tremendous amount of research.

The remaining chapters are devoted to a systematic systemic consideration of the applicability of high frequency currents to disease. The etiology and brief symptomatology is always considered together with the therapy indicated. Where beneficial, case reports are included. The works of other authorities are interwoven in the discourse.

In its new form this edition presents the life work of one who has been devoutly engrossed in his task in such a manner as to make it readily available for those for whom it was designed—the student and general practitioner.